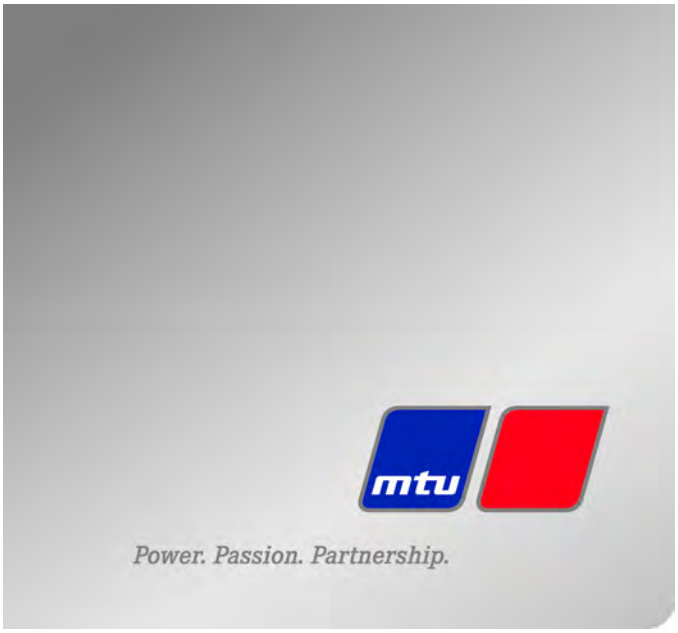
Operating Instructions

Diesel engine
12 V 2000 M94
16 V 2000 M94

MS150061/04E



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This handbook is provided for use by maintenance and operating personnel in order to avoid malfunctions or damage during operation.

Subject to alterations and amendments.

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1 Safety

1.1 General conditions

General

In addition to the instructions in this publication, the applicable country-specific legislation and other compulsory regulations regarding accident prevention and environmental protection must be observed. This state-of-the-art engine has been designed to meet all applicable laws and regulations. The engine may nevertheless present a risk of injury or damage in the following cases:

- Incorrect use
- Operation, maintenance and repair by unqualified personnel
- Modifications or conversions
- Noncompliance with the Safety Instructions

Correct use

The engine is intended solely for use in accordance with contractual agreements and the purpose envisaged for it on delivery. Any other use is considered improper use. The engine manufacturer accepts no liability whatsoever for resultant damage or injury in such case. The responsibility is borne by the user alone.

Correct use also includes observation of and compliance with the maintenance specifications.

Modifications or conversions

Unauthorized modifications to the engine represent a safety risk.

MTU will accept no liability or warranty claims for any damage caused by unauthorized modifications or conversions.

Spare parts

Only genuine MTU spare parts must be used to replace components or assemblies. MTU accepts no liability whatsoever for damage or injury resulting from the use of other spare parts and the warranty shall be voided in such case.

Reworking components

Repair or engine overhaul must be carried out in workshops authorized by MTU.

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1.2 Personnel and organizational requirements

Personnel requirements

All work on the engine shall be carried out by trained and qualified personnel only.

The specified legal minimum age must be observed.

The operator must specify the responsibilities of the operating, maintenance and repair personnel.

Organizational measures

This publication must be issued to all personnel involved in operation, maintenance, repair or transportation.

Keep it at hand at the operating site of the engine so that it is available to operating, maintenance, repair and transport personnel at all times.

Use the manual as a basis for instructing personnel on engine operation and repair with an emphasis on explaining safety-relevant instructions.

This is particularly important in the case of personnel who only occasionally perform work on or around the engine. This personnel must be instructed repeatedly.

For the identification and layout of the spare parts during maintenance or repair work, take photos or use the spare parts catalog.

Working clothes and protective equipment

Wear proper protective clothing for all work.

Use the necessary protective equipment for the given work to be done.

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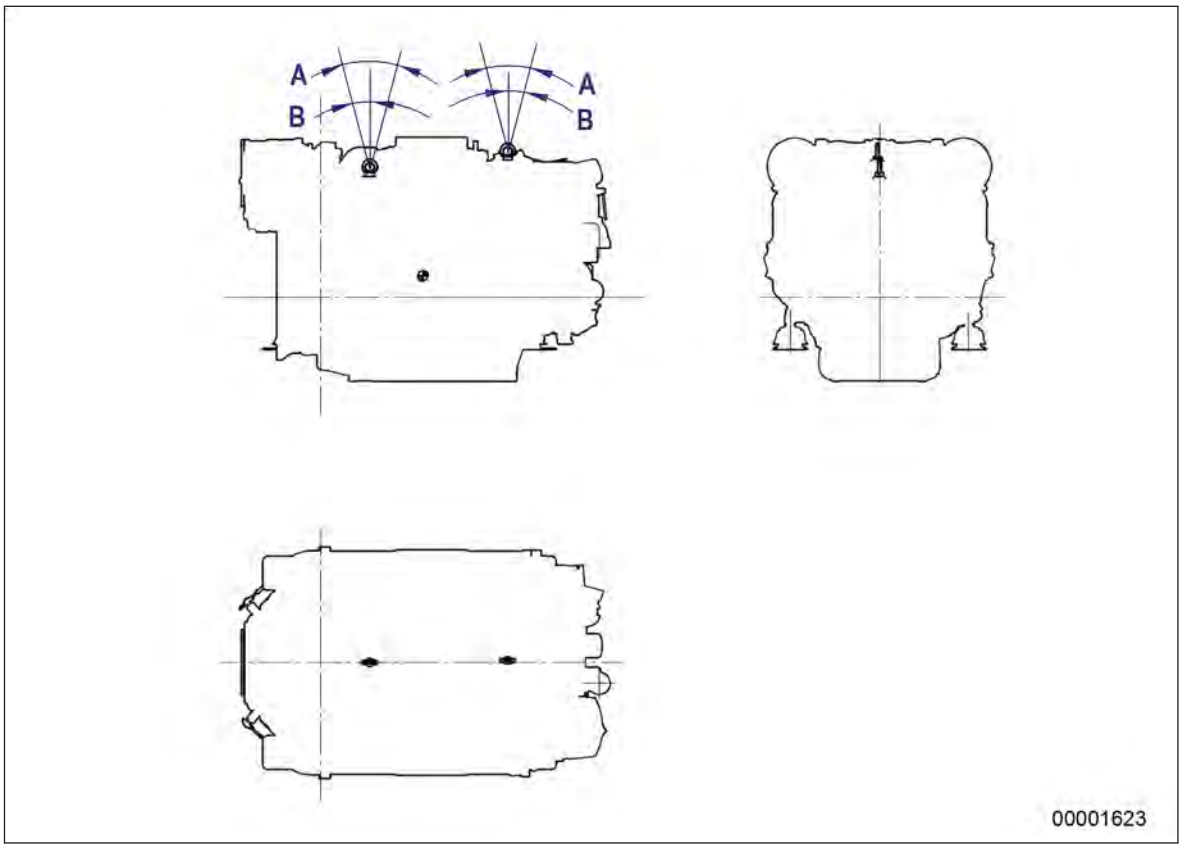
1.3 Transport

Transport without flange-mounted gearbox



A max. permissible diagonal pull 70°

B max. permissible diagonal pull 35°

Illustration is valid for 12/16V 2000 M engines

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Transport with flange-mounted gearbox

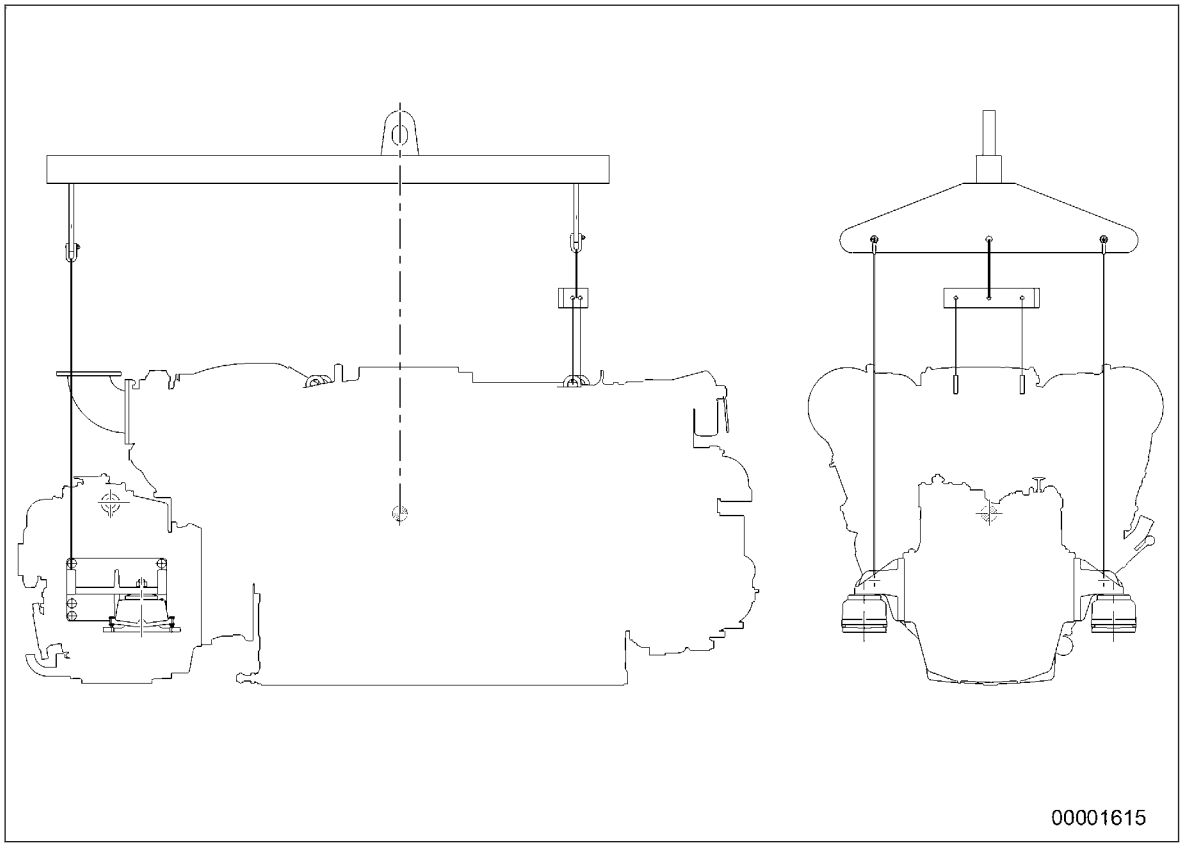

Illustration is valid for 12/16V 2000 M engines

Lift the engine only with the lifting eyes provided.

The eyebolts mounted at the driving end and on the gearbox must not be used for transporting plants with flange-mounted gearboxes.

Only use transport and lifting devices approved by MTU.

Take the engine's center of gravity into account.

The engine must only be transported in installation position, max. permissible diagonal pull with flange-mounted gearbox is 10°.

If the engine is supplied with special aluminum foil packing, lift the engine at the lifting eyes of the bearing pedestal or use a means of transportation which is appropriate for the given weight (forklift truck).

Install the crankshaft locking device and the locking screws for the engine mounts prior to engine transportation.

Secure the engine against tilting during transport. In particular when going down inclines or ramps, the engine must be secured against moving and tilting.

Setting the engine down after transport

Only set down engine on a firm, level surface.

Make sure that the consistency and load-bearing capacity of the ground or support surface is adequate.

Never set an engine down on the oil pan unless expressively authorized to do so by MTU on a case-to-case basis.

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1.4 Safety regulations for startup and operation

Safety precautions when putting the equipment into operation

Prior to initial operation of the assembly or plant, install the assembly or unit according to the specifications and check the installation according to the MTU specifications.

Before putting the device or plant into operation, always ensure:
- that all maintenance and repair work is completed,
- that all loose parts have been removed from rotating machine components,
- that all persons are clear of the danger zone of moving machine components.

Immediately after putting the device or plant into operation, make sure that all control and display instruments as well as the monitoring, signaling and alarm systems are working properly.

Safety regulations for equipment operation

Emergency procedures must be practiced regularly.

The operator must be familiar with the controls and displays.

The operator must be familiar with the consequences of all operations to be performed.

During operation, the display instruments and monitoring units must be permanently observed with regard to present operating status, violation of limit values and warning or alarm messages.

The following steps must be taken if a malfunction of the system is recognized or reported by the system:
- inform supervisor(s) in charge,
- analyze the message,
- if required, carry out emergency operations e.g. emergency engine stop.

Engine operation

The following conditions must be fulfilled before starting the engine:
- Wear ear protectors.
- Ensure that the engine room is well ventilated.
- Do not inhale engine exhaust gases.
- Ensure that the exhaust system is free of leaks and that the gases are discharged to atmosphere.
- Mop up any leaked or spilled fluids and lubricants immediately or soak up with a suitable binding agent.
- Protect battery terminals, battery-charger terminals and cables against accidental contact.
- When the engine is running, never release coolant, oil, fuel, compressed-air or hydraulic lines.

Operation of electrical equipment

When operating electrical equipment, certain components of this equipment are live.

Observe the safety instructions for these devices.

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1.5 Safety regulations for maintenance and repair work

Safety regulations for maintenance and repair work

Have maintenance and repair work carried out by qualified and authorized personnel only.

Allow the engine to cool down before starting maintenance work (risk of explosion of oil vapors).

Before starting work, relieve pressure in systems and compressed-air lines which are to be opened.

Take special care when removing ventilation or plug screws from the engine. Cover the screw or plug with a rag to prevent fluids escaping under pressure.

Take special care when draining hot fluids ⇒ Risk of injury.

When changing the engine oil or working on the fuel system, ensure that the engine room is adequately ventilated.

Allow the engine / system to cool down before starting to work.

Observe the maintenance and repair instructions.

Never carry out maintenance and repair work with the engine running unless expressly instructed to do so.

Secure the engine against accidental starting.

Disconnect the battery when electrical starters are fitted.

Close the main valve on the compressed-air system and vent the compressed-air line when pneumatic starters are fitted.

Disconnect the control equipment from the assembly or system.

Use only proper, calibrated tools. Observe the specified tightening torques during assembly/disassembly.

Carry out work only on assembles and/or units which are properly secured.

Never use lines for climbing.

Keep fuel injection lines and connections clean.

Always seal connections with caps or covers if a line is removed or opened.

Take care not to damage lines, in particular fuel lines, during maintenance and repair work.

Ensure that all retainers and dampers are installed correctly.

Ensure that all fuel injection and pressurized oil lines are installed with enough clearance to prevent contact with other components. Do not place fuel or oil lines near hot components.

Do not touch elastomeric seals if they have carbonized or resinous appearance unless hands are properly protected.

Note cooling time for components which are heated for installation or removal ⇒ Risk of burning.

When working high on the engine, always use suitable ladders and work platforms. Make sure components are placed on stable surfaces.

Observe special cleanness when conducting maintenance and repair work on the assembly or system. After completion of maintenance and repair work, make sure that no loose objects are in/on the assembly or system.

Before barring the engine, make sure that nobody is standing in the danger zone. Check that all guards have been reinstalled and that all tools and loose parts have been removed after working on the engine.

The following additional instructions apply to starters with beryllium copper pinion:

- Breathing protection of filter class P2 must be applied during maintenance work to avoid health hazards caused by the beryllium-containing pinion. Do not blow out the interior of the flywheel housing or the starter with compressed air. Clean the flywheel housing inside with a class H dust extraction device as an additional measure.

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Welding work

Never carry out welding work on the assembly, system, or engine-mounted units. Cover the engine when welding in its vicinity.

Do not use the assembly or system as ground terminal.

Do not route the welding lead over or near the wiring harnesses of MTU systems. The welding current may otherwise induce an interference voltage in the wiring harnesses which could conceivably damage the electrical system.

Remove parts (e.g. exhaust pipes) which are to be welded from the engine beforehand.

Hydraulic installation and removal

Check the function and safe operating condition of tools and fixtures to be used. Use only the specified devices for hydraulic removal/installation procedures.

Observe the max. permissible push-on pressure specified for the equipment.

Do not attempt to bend or apply force to lines.

Before starting work, pay attention to the following:
- Vent the hydraulic installation/removal tool, the pumps and the lines at the relevant points for the equipment to be used (e.g. open vent plugs, pump until bubble-free air emerges, close vent plugs).
- For hydraulic installation, screw on the tool with the piston retracted.
- For hydraulic removal, screw on the tool with the piston extended.

For a hydraulic installation/removal tool with central expansion pressure supply, screw spindle into shaft end until correct sealing is established.

During hydraulic installation and removal, ensure that nobody is standing in the immediate vicinity of the component to be installed/removed.

Working on electrical/electronic assemblies

Always obtain the permission of the person in charge before commencing maintenance and repair work or switching off any part of the electronic system required to do so.

De-energize the appropriate areas prior to working on assemblies.

Do not damage cabling during removal work. When reinstalling ensure that wiring is not damaged during operation by contact with sharp objects, by rubbing against other components or by a hot surface.

Do not secure cables on lines carrying fluids.

Do not use cable binders to secure cables.

Always use connector pliers to tighten connectors.

Subject the device or system to a function check on completion of all repair work.

Store spare parts properly prior to replacement, i.e. protect them against moisture in particular. Pack defective electronic components and assemblies in a suitable manner when dispatched for repair, i.e. particularly protected against moisture and impact and wrapped in antistatic foil if necessary.

Working with laser equipment

When working with laser equipment, always wear special laser-protection goggles ⇒ Heavily focused radiation.

Laser equipment must be fitted with the protective devices necessary for safe operation according to type and application.

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For conducting light-beam procedures and measurement work, only the following laser devices must be used:

- Laser devices of classes 1, 2 or 3A.
- Laser devices of class 3B, which have maximum output in the visible wavelength range (400 to 700 nm), a maximum output of 5 mW, and in which the beam axis and surface are designed to prevent any risk to the eyes.

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1.6 Auxiliary materials, fluids and lubricants, fire prevention and environmental protection

Fire prevention

Rectify any fuel or oil leaks immediately; even splashes of oil or fuel on hot components can cause fires – therefore always keep the engine in a clean condition. Do not leave cloths soaked with fluids and lubricants lying on or near the assembly or unit. Do not store inflammable material near the assembly or unit.

Do not weld pipes and components carrying oil or fuel! Before welding, clean with a nonflammable fluid.

When starting the engine with an external power source, connect the ground lead last and remove it first. To avoid sparks in the vicinity of the battery, connect the ground lead from the external power source to the ground lead of the engine or to the ground terminal of the starter.

Always keep suitable firefighting equipment (fire extinguishers) at hand and familiarize yourself with their use.

Noise

Noise can lead to an increased risk of accident if acoustic signals, warning shouts or noises indicating danger are drowned.

Wear ear protectors in work areas with a sound pressure level in excess of 85 dB (A).

Environmental protection and disposal

Modification or removal of mechanical or electronic components or the installation of additional components as well as the execution of calibration processes that might affect the emission characteristics of the engine are prohibited by emission regulations. Emission control units/systems may only be maintained, exchanged or repaired if the components used for this purpose are approved by MTU or equivalent components. Noncompliance with these guidelines might represent a violation of the Clean Air Act and involves the termination of the operating license by the emission authorities. MTU does not accept any liability for violations of the emission regulations. MTU will provide assistance and advice if emission-relevant components are intended to be modified. The MTU Maintenance Schedules ensure the reliability and performance of MTU engines and must be complied with over the entire life cycle of the engine.

Use only fuel of prescribed quality to comply with emission limit values.

Dispose of used fluids, lubricants and filters in accordance with local regulations.

Within the EU, batteries can be returned free of charge to MTU FN / MTU Onsite Energy where they are subjected to proper recycling procedures.

Auxiliary materials, fluids and lubricants

Use only fluids and lubricants that have been tested and approved by MTU.

The Fluids and Lubricants Specifications will be amended or supplemented as necessary. Before using them, make sure you have the latest version. The latest version is also available at: http://www.mtu-online.com/mtu/mtu-valuecare/mtu-valueservice-Technische-Dokumentation.

Keep fluids and lubricants in suitable, properly designated containers. When using fluids, lubricants and other chemical substances, follow the safety instructions that apply to the product. Take special care when using hot, chilled or caustic materials. When using flammable materials, avoid all sparks and do not smoke.

Used oil

Used oil contains harmful combustion residues.

Rub barrier cream into hands.

Wash hands after contact with used oil.

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Lead

- When working with lead or lead-containing compounds, avoid direct contact to the skin and do not inhale lead vapors.
- Adopt suitable measures to avoid the formation of lead dust.
- Switch on extraction system.
- Wash hands after contact with lead or lead-containing substances.

Compressed air

Observe special safety precautions when working with compressed air:

- Pay special attention to the pressure level in the compressed air network and pressure vessel.
- Assemblies and equipment to be connected must either be designed for this pressure, or, if the permitted pressure for the connecting elements is lower than the pressure required, a pressure reducing valve and safety valve (set to permitted pressure) must form an intermediate connection.
- Hose couplings and connections must be securely attached.
- Wear goggles when blowing off components or blowing away chips.
- Provide the snout of the air nozzle with a protective disk (e.g. rubber disk).
- First shut off compressed air lines before compressed air equipment is disconnected from the supply line, or before equipment or tool is to be replaced.
- Unauthorized use of compressed air, e.g. forcing flammable liquids (danger class AI, AII and B) out of containers, results in a risk of explosion.
- Forcing compressed air into thin-walled containers (e.g. containers made of tin, plastic and glass) for drying purposes or to check for leaks, results in a risk of bursting.
- Carry out leak test in accordance with the specifications.

Paints and lacquers

- When carrying out painting work outside the spray stands provided with fume extraction systems, ensure that the area is well ventilated. Make sure that neighboring work areas are not impaired.
- No open flames.
- No smoking.
- Observe fire prevention regulations.
- Always wear a mask providing protection against paint and solvent vapors.

Liquid nitrogen

- Store liquid nitrogen only in small quantities and always in regulation containers without fixed covers.
- Avoid body contact (eyes, hands).
- Wear protective clothing, protective gloves, closed shoes and protective goggles / safety mask.
- Make sure that working area is well ventilated.
- Avoid all knocks and jars to the containers, fixtures or workpieces.

Acids and alkaline solutions

- When working with acids and alkaline solutions, wear protective goggles or face mask, gloves and protective clothing.
- If such solutions are spilled onto clothing, remove the affected clothing immediately.
- Rinse injured parts of the body thoroughly with clean water.
- Rinse eyes immediately with eyedrops or clean tap water.

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1.7 Conventions for safety instructions in the text

DANGER	In the event of immediate danger. **Consequences: Death or serious injury** • Remedial action
WARNING	In the event of potentially dangerous situations. **Consequences: Death or serious injury** • Remedial action
CAUTION	In the event of dangerous situations. **Consequences: Minor injury or material damage** • Remedial action
NOTICE	In the event of a situation involving potentially adverse effects on the product. **Consequences: Material damage.** • Remedial action • Additional product information

Note: This manual contains highlighted safety warnings in accordance with the US ANSI Z535 standard which begin with one of the signal words listed above depending on the severity of the hazard.

Safety instructions

1. Read and familiarize yourself with all safety notices before starting up or repairing the product.
2. Pass on all safety instructions to your operating, maintenance, repair and transport personnel.

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2 General Information

2.1 Tightening specifications for screws, nuts and bolts

Tightening torques for setscrew and stud joints as per MTN 5008 standard

This works standard applies to setscrews subjected to little dynamic load as per MMN 384, DIN 912, EN 24014 (DIN 931-1), EN 24017 (DIN 933), EN 28765 (DIN 960), EN 28676 (DIN 961), DIN 6912 and to studs as per DIN 833, DIN 835, DIN 836, DIN 938, DIN 939 and associated nuts.

It does not apply to heat-resistant screws in the hot component area.

Tightening torques M_A are specified for screws of strength class 8.8 (surface condition bare, phosphatized or galvanized) and 10.9 (surface condition bare or phosphatized).

The values given in the table are based on a friction coefficient μtot.= 0.125. Prerequisite: Threads and mating faces of screws and nuts must be lubricated with engine oil prior to assembly.

When tightening manually (tightening specifications), an assembly tolerance of +10% of the table values is permitted for unavoidable deviations of the tightening torque from the table value during the tightening process – e.g. resulting from inaccurate readings and overtightening during assembly.

When machine-tightening, the permissible assembly tolerance is +15 %.

Thread	Hand-tightening		Machine-tightening	
	8.8 M_A (Nm)	10.9 M_A (Nm)	8.8 M_A (Nm)	10.9 M_A (Nm)
M6	9	12	8	11
M8	21	31	20	28
M8 x 1	23	32	21	30
M10	42	60	40	57
M10 x 1.25	45	63	42	60
M12	74	100	70	92
M12 x 1.25	80	110	75	105
M12 x 1.5	76	105	72	100
M14	115	160	110	150
M14 x 1.5	125	180	120	170
M16	180	250	170	235
M16 x 1.5	190	270	180	255
M18	250	350	240	330
M18 x 1.5	280	400	270	380
M20	350	500	330	475
M2 x 1.5	390	550	350	520
M22	480	680	450	650
M22 x 1.5	520	730	490	700
M24	600	850	570	810
M24 x 1.5	680	950	640	900
M24 x 2	660	900	620	850
M27	900	1250	850	1175

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Thread	Hand-tightening		Machine-tightening	
	8.8 M_A (Nm)	10.9 M_A (Nm)	8.8 M_A (Nm)	10.9 M_A (Nm)
M27 x 2	960	1350	900	1275
M30	1200	1700	1100	1600
M30 x 2	1350	1900	1250	1800

M_A= tightening torques

Tightening torques for stress bolt connections as per MTN 5007 standard

This standard applies to statically and dynamically loaded stress bolt connections of strength class 10.9 and for corresponding nuts.

Shaft and transition dimensions as per MMN 209 standard and material and machining as per MMN 389 standard (bright surface or phosphatized).

The values given in the table are based on a friction coefficient µtot.= 0.125. Prerequisite: Threads and mating faces of screws and nuts must be lubricated with engine oil prior to assembly.

When tightening manually (defined tightening), an assembly tolerance of +10 % of the table values is permitted for unavoidable deviations of the tightening torque from the table value during the tightening process – e.g. resulting from inaccurate readings and overtightening during assembly.

The values in the tables are for manual tightening using a torque wrench.

Thread	Not torsion-protected M_A(Nm)	Torsion-protected M_A(Nm)
M6	9	12
M8	21	28
M8 x 1	24	30
M10	42	55
M10 x 1.25	46	60
M12	75	93
M12 x 1.5	78	99
M14	120	150
M14 x 1.5	135	160
M16	180	225
M16 x 1.5	200	245
M18	250	315
M18 x 1.5	300	360
M20	350	450
M20 x 1.5	430	495
M22	500	620
M22 x 1.5	560	675
M24	640	790
M24 x 2	700	850
M27	900	1170
M27 x 2	1000	1230
M30	1250	1575

*Protect screw shank against torsion when tightening.

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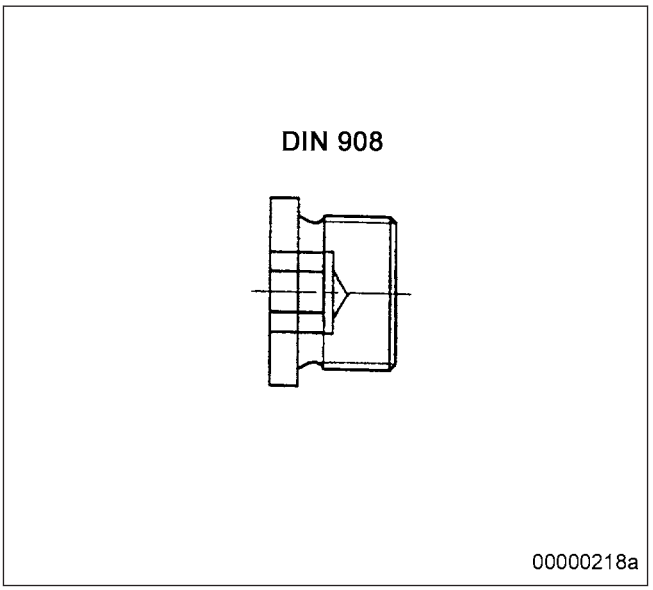
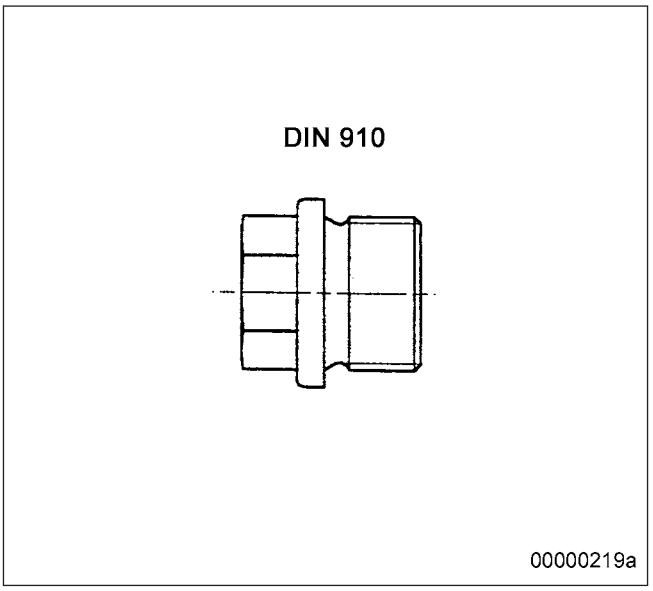
M_A= tightening torques

Tightening torques for plug screws as per MTN 5183-1 standard

This standard applies to plug screws as per DIN 908, DIN 910 and DIN 7604 with screwed plug DIN 3852 shape A (sealed by sealing ring DIN 7603-Cu).





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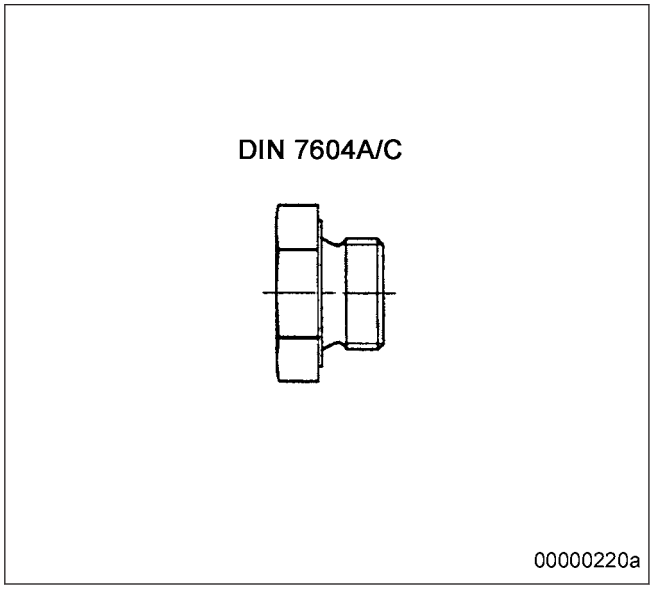


Tightening torques M_A are given for plug screws made of steel (St) with phosphatized surface-protection and oiled or galvanized. Thread and mating faces beneath heads must be coated in engine oil prior to assembly. When tightening manually (defined tightening), an assembly tolerance of +10 % of the table values is permitted for unavoidable deviations of the tightening torque from the table value during the tightening process – e.g. resulting from inaccurate readings and overtightening during assembly.

Tightening torques for plug screws DIN 908, DIN 910 and DIN 7604A (with short screwed plug).

Thread	Screwed into	
	Steel/gray cast iron M_A (Nm)	Al alloy M_A (Nm)
M10 x 1	15	15
M12 x 1.5	30	25
M14 x 1.5	35	30
M16 x 1.5	40	35
M18 x 1.5	50	40
M20 x 1.5	60	50
M22 x 1.5	70	70
M24 x 1.5	85	80
M26 x 1.5	100	100
M27 x 2	100	100
M30 x 1.5	110	110
M30 x 2	120	120
M33 x 2	160	160
M36 x 1.5	190	180
M38 x 1.5	220	200
M42 x 1.5	260	240
M45 x 1.5	290	270
M48 x 1.5	310	*300
M52 x 1.5	325	320

TIM-ID: 0000002333 - 010

Thread	Screwed into	
	Steel/gray cast iron M_A (Nm)	Al alloy M_A (Nm)
M56 x 2	380	360
M64 x 2	400	400

M_A= tightening torques

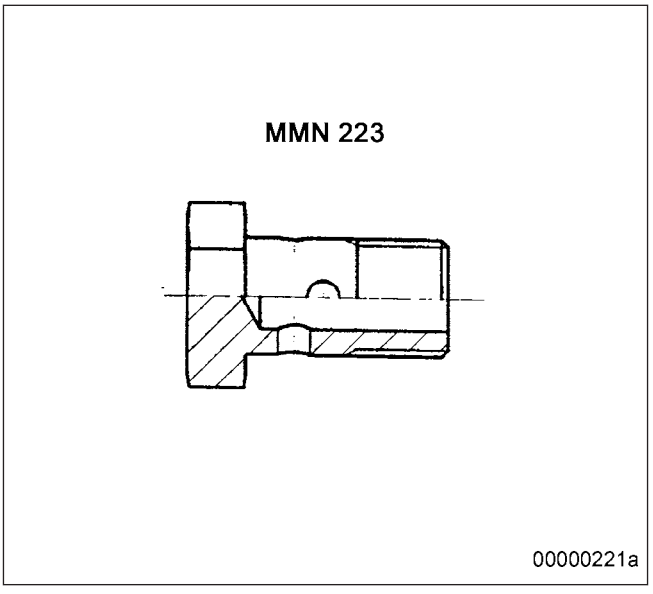
Tightening torques for plug screws DIN 7604C (with long screwed plug)

Thread	Screwed into	
	Steel/gray cast iron M_A (Nm)	Al alloy M_A (Nm)
M8 x 1	10	10
M22 x 1.5	80	65
M26 x 1.5	105	90
M30 x 1.5	130	130
M38 x 1.5	140	120
M45 x 1.5	160	140

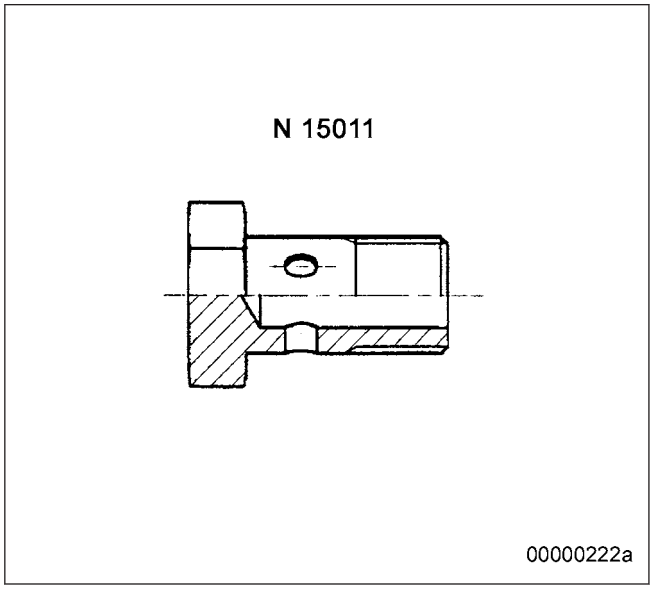
M_A= tightening torques

Tightening torques for banjo screws as per MTN 5183-2 standard

This standard applies to banjo screws as per MMN 223 and N 15011 sealed with sealing ring DIN 7603-Cu.



TIM-ID: 0000002333 - 010



The stated tightening torques M_A apply to steel (St) banjo screws with a phosphatized surface and oiled or galvanized and for copper-aluminum alloy.

Thread and mating faces beneath heads must be coated with engine oil prior to assembly.

When tightening manually (defined tightening), an assembly tolerance of +10 % of the table values is permitted for unavoidable deviations of the tightening torque from the table value during the tightening process – e.g. resulting from inaccurate readings and overtightening during assembly.

Tightening torques for steel banjo screws

Thread	Screwed into steel/gray cast iron/Al alloy M_A (Nm)
M8 x 1	10
M10 x 1	15
M12 x 1.5	20
M14 x 1.5	25
M16 x 1.5	25
M18 x 1.5	30
M22 x 1.5	60
M26 x 1.5	90
M30 x 1.5	130
M38 x 1.5	140
M45 x 1.5	160

M_A= tightening torques

Tightening torques for copper-aluminum alloy banjo screws

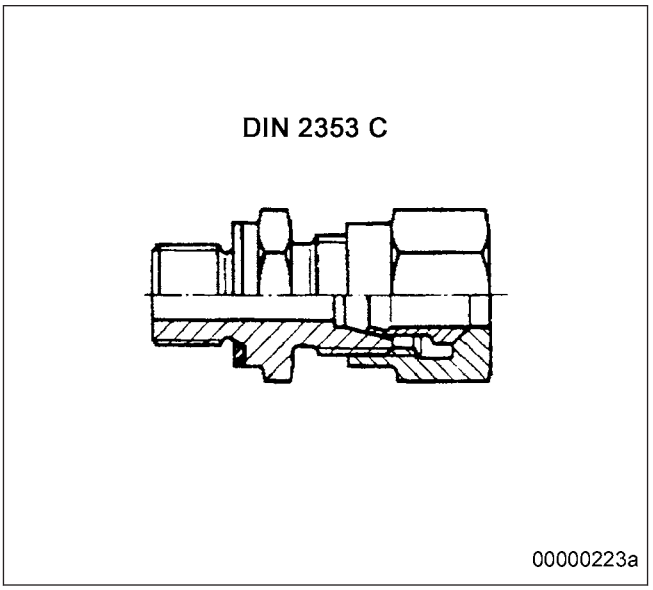
Thread	Screwed into steel/gray cast iron/Al alloy M_A (Nm)
M10 x 1	15
M16 x 1.5	30

M_A= tightening torques

TIM-ID: 0000002333 - 010

Tightening torques for male connectors as per MTN standard 5183-3

This standard applies to male connectors DIN 2353, L series, with screwed plug DIN 3852, model A (sealed by sealing ring DIN 7603-Cu).



Tightening torques M_A are given for male connectors made of steel (St) with surface protected by a phosphate coating and oiled or galvanized.

Thread and mating faces beneath heads must be coated with engine oil prior to assembly.

When tightening manually (defined tightening), an assembly tolerance of +10 % of the table values is permitted for unavoidable deviations of the tightening torque from the table value during the tightening process – e.g. resulting from inaccurate readings and overtightening during assembly.

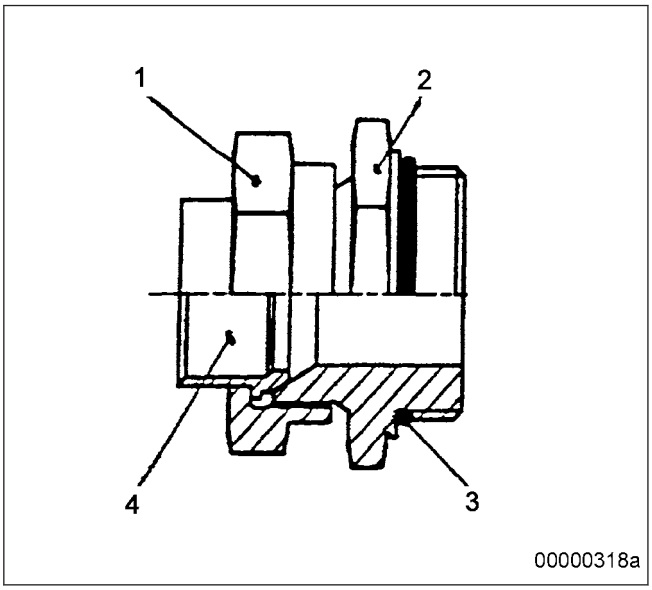
Thread	Screwed into steel/gray cast iron M_A (Nm)
M10 x 1	15
M12 x 1.5	20
M14 x 1.5	35
M16 x 1.5	50
M18 x 1.5	60
M22 x 1.5	70
M26 x 1.5	100
M32 x 2	160
M42 x 2	260
M48 x 2	320

M_A= tightening torques

TIM-ID: 0000002333 - 010

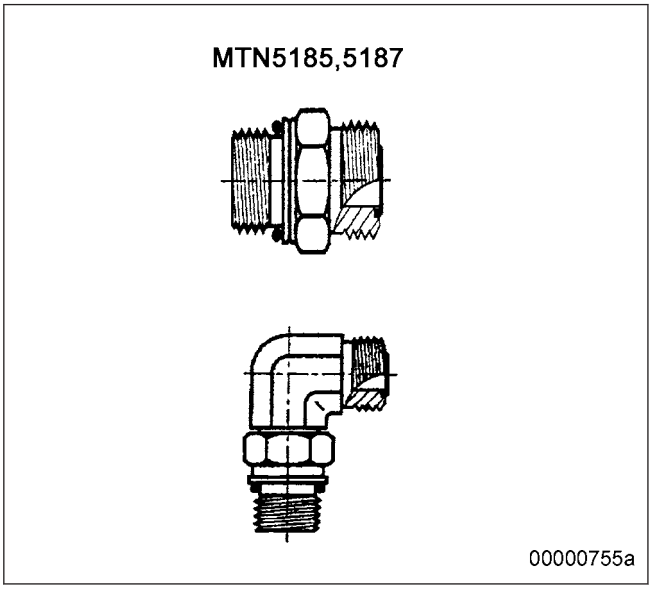
Tightening torques for union nuts as per DIN 3859-2

1 Union nut
2 Screw fixture
3 O-ring
4 Linear ball bearing



Union nut: When installing the linear ball bearing, after firm hand-tightening (noticeable increase in force) the union nut is further tightened by a quarter of a rotation (90°) beyond this point.

Tightening torques for screwed plugs with O-ring as per ISO 6149-2

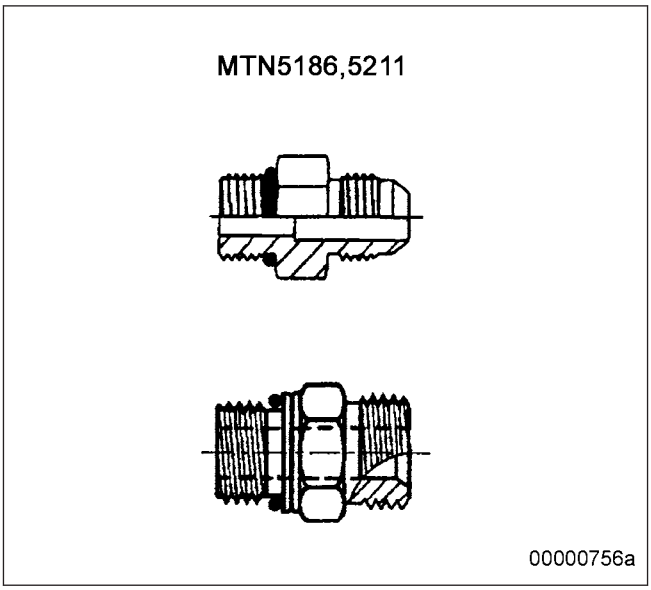


Thread	Torque (Nm) + 10%
M8 x 1	10
M10 x 1	20
M12 x 1.5	35
M14 x 1.5	45
M16 x 1.5	55
M18 x 1.5	70
M20 x 1.5[1)]	80
M22 x 1.5	100

TIM-ID: 0000002333 - 010

Thread	Torque (Nm) + 10%
M27 x 2	170
M33 x 2	310
M42 x 2	330
M48 x 2	420
M60 x 2	500
[1)]Only for closing off installation spaces for screw-in valves (see ISO 7789)	

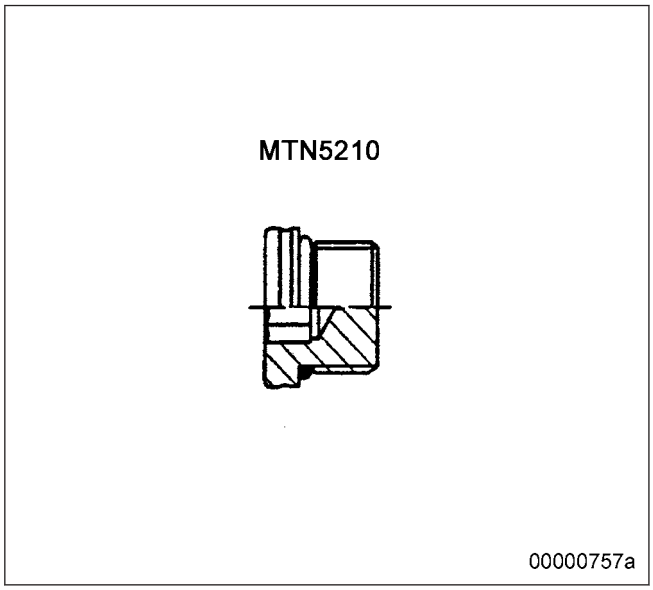
Tightening torques for screwed plugs with O-ring as per ISO 6149-3



Thread	Torque (Nm) + 10%
M8 x 1	8
M10 x 1	15
M12 x 1.5	25
M14 x 1.5	35
M16 x 1.5	40
M18 x 1.5	45
M22 x 1.5	60
M27 x 2	100
M33 x 2	160
M42 x 2	210
M48 x 2	260
M60 x 2	315

TIM-ID: 0000002333 - 010

Tightening torques for plug screws as per MTN 5183-6



Thread	Screwed into	
	Steel/gray cast iron M_A (Nm)	Al alloy M_A (Nm)
M10 x 1	20	10+ 2
M12 x 1.5	35	14+ 2
M14 x 1.5	45	15+ 3
M16 x 1.5	55	18+ 3
M18 x 1.5	70	23+ 3
M22 x 1.5	100	33+ 4
M27 x 2	170	57+ 5
M33 x 2	310	103+ 10
M42 x 2	330	110+ 11
M48 x 2	420	140+ 14
M60 x 2	[1]	200+ 20
[1] Value still to be determined		

Assembly instructions and tightening torques for hose fittings with union nuts

In contrast to the instructions for pipe unions, hose fittings with sealing heads and the associated adapters must be installed and connected as follows (these instructions do not apply to ORFS fittings).

Hose fitting, metallic sealing with union nut: Tighten union nut by hand then tighten a further max. 1/4 of a revolution with a wrench.

Hose fitting with O-ring and union nut: Tighten union nut by hand then tighten a further max. 1/2 of a revolution with a wrench.

Hoses must be suitably aligned before tightening the union nuts.

TIM-ID: 0000002333 - 010

Sealing head/sealing cone with metric union nut		
Metric thread	Pipe outer dia.	Torque (Nm)
M12 x 1.5	6	20
M14 x 1.5	8	38
M16 x 1.5	8 10	45
M18 x 1.5	10 12	51
M20 x 1.5	12	58
M22 x 1.5	14 15	74
M24 x 1.5	16	74
M26 x 1.5	18	105
M30 x 2	20 22	135
M36 x 2	25 28	166
M42 x 2	30	240
M45 x 2	35	290
M52 x 2	38 42	330

Sealing head with BSP union nut	
BSPP thread	Torque (Nm)
G1/4	20
G3/8	34
G1/2	60
G5/8	69
G3/4	115
G1	140
G1.1/4	210
G1.1/2	290
G2	400

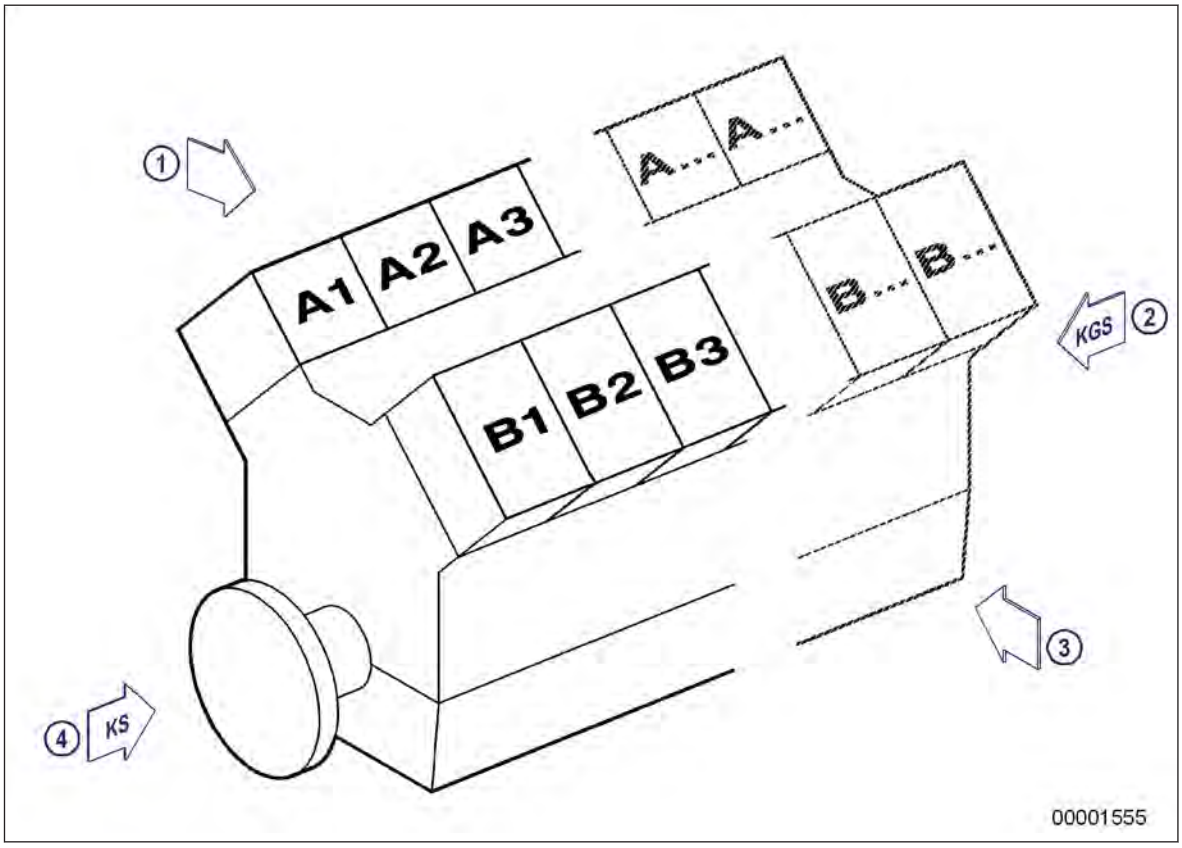
TIM-ID: 0000002333 - 010

2.2 Engine side and cylinder designations

Engine sides are always designated as viewed from the driving end (KS).

The cylinders of the left engine side are designated "A" and those of the right side "B" (as per DIN ISO 1204). The cylinders of each bank are numbered consecutively, starting with No. 1 at the driving end.

Other components are numbered in the same way, i.e. starting with No. 1 on driving end.



1 Left engine side
2 KGS = Free end
3 Right engine side
4 KS = Driving end

TIM-ID: 0000002185 - 010

2.3 Product description

Description of the engine

Engine

The engine is a liquid-cooled four-stroke diesel engine with c.c.w. direction of rotation, direct injection, sequential turbocharging and charge-air cooling.

An electronic management system provides engine control and monitoring.

Fuel system with common rail injection

Controlled by the engine electronics, the common rail injection system determines injection pressure, injection timing and injection quantity independently of the engine speed.

Injection pressures up to 1800 bar ensure optimum fuel injection and combustion conditions.

Charging system

The charging system comprises charge-air system, exhaust system and sequential turbocharging.

The exhaust system is equipped with triple-walled, water-cooled exhaust lines.

The triple-walled design permits
- low surface temperature,
- reduced thermal load,
- absolute gas-tightness.

Lube oil system

Wet-sump forced-feed lubrication system

Components supplied with oil:
- Bearings
- Piston cooling
- Control and actuating elements of the sequential turbocharging system

Cooling system

- Two separate cooling circuits:
  - Engine coolant
  - Raw water
- Coolant cooling by raw water-cooled plate-core heat exchanger
- Thermostat-controlled coolant system
- Coolant-cooled / preheated charge air
- Coolant-cooled fuel return

Electronic system

Electronic control and monitoring system with integrated security and test system with interfaces to remote control system (RCS) and to monitoring system (MCS).

Electronic engine control unit (ECU)

Closed-loop control:
- Engine speed
- Fuel HP

TIM-ID: 0000002177 - 002

Open-loop control:
- Injection (fuel pressure, injection timing, injection duration, operating status)
- Sequential turbocharging (cutting-in and out) with secondary turbocharger
- Engine protection with multi-stage safety systems:
  - Power reduction
  - Power limitation
  - Emergency stop

Monitoring:
- Exhaust gas temperature, A-side
- Exhaust temperature, B-side
- Engine speed
- Oil pressure
- Differential oil pressure
- Coolant temperature
- Coolant level
- Exhaust turbocharger speed
- Leak fuel level
- Oil temperature
- Coolant pressure
- Fuel pressure after filter

Monitoring in engine room

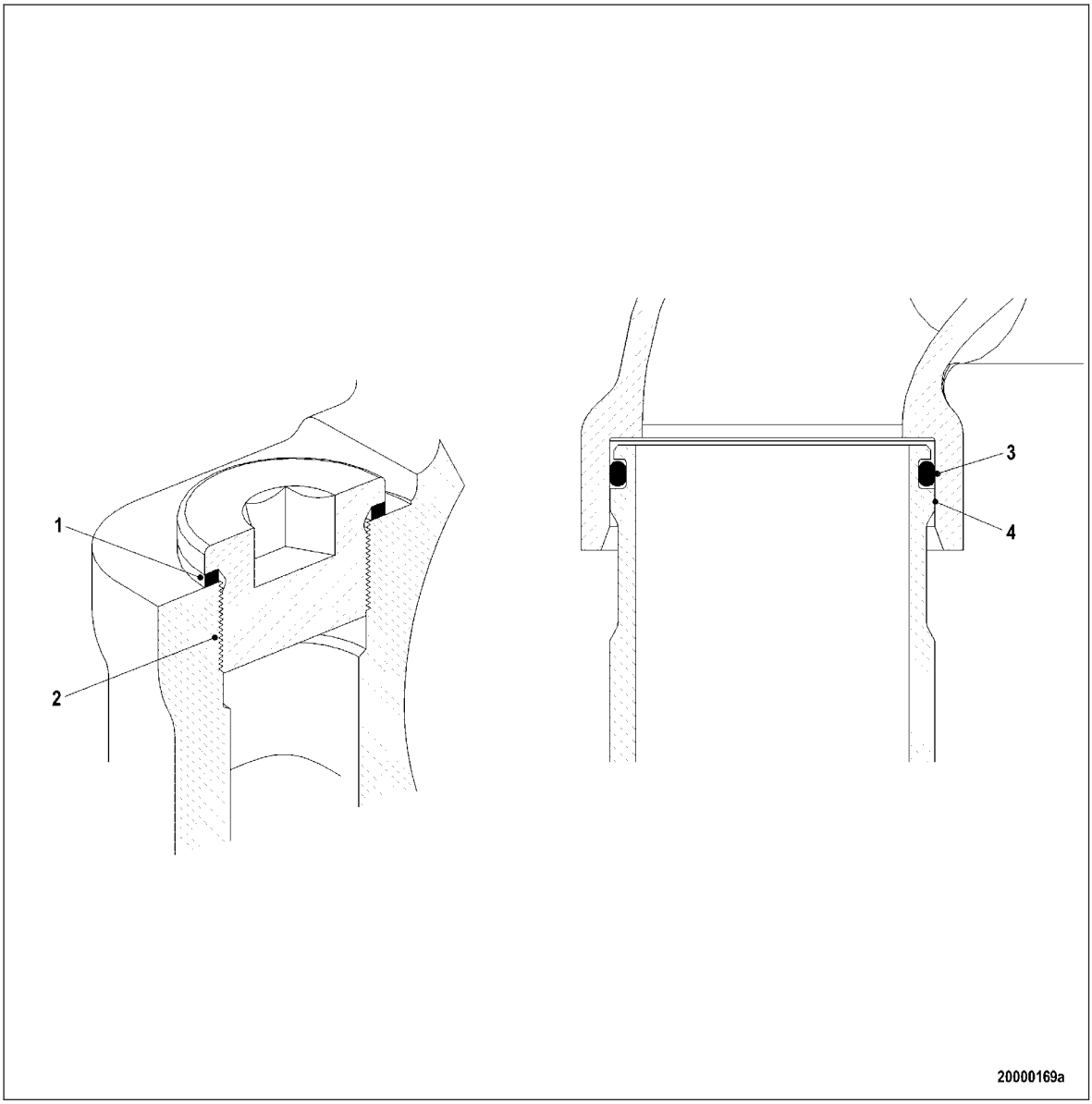
Engine control and monitoring unit (LOP)

Functions:
- Engine speed, oil pressure and coolant temperature are monitored and displayed
- Integrated safety system
- Integrated test system
- Redundant CAN bus interface to governor and higher-level control and monitoring system
- 24 V DC power supply

TIM-ID: 0000002177 - 002

SOLAS – Fire protection specifications

Special connections



In case of leakage, the above-mentioned connection types are spray-protected even without a cover and have been confirmed compliant with SOLAS by GL and DNV.

Plug-in pipe connection

The sleeve (4) covers the joint to prevent lateral spray.

Only leak-off along the line is possible, the pressure is decreased significantly if an O-ring (3) defect occurs.

The connection is confirmed as compliant with SOLAS by DNV and GL.

Plugs and sensors

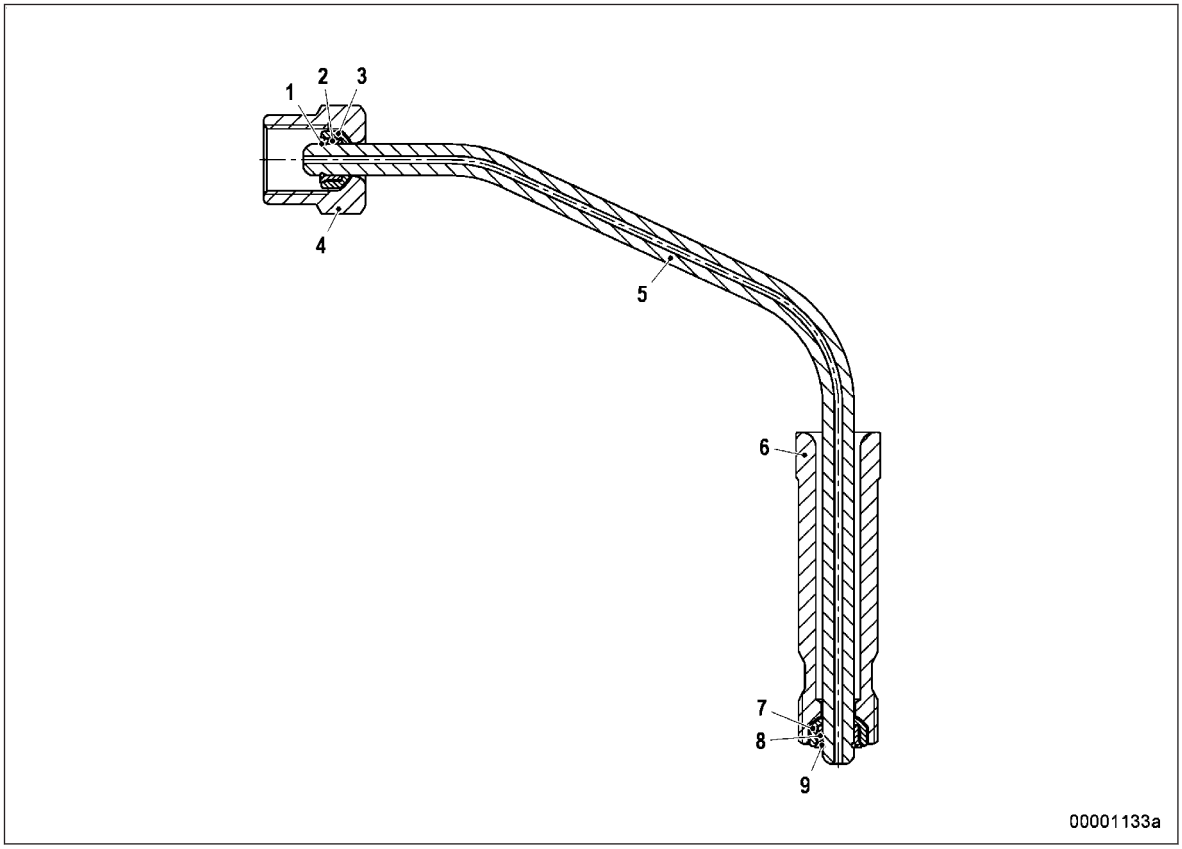
Screw-in plugs (2) are sealed toward the outside either with a copper sealing ring (1), according to DIN, or an O-ring (ISO).

In case of a loose single-ended union or a defective sealing ring (2), the liquid first has to pass the thread.

TIM-ID: 0000002177 - 002

The pressure is so greatly reduced by this and the faulty sealing ring (2) that any leakage is not under pressure.

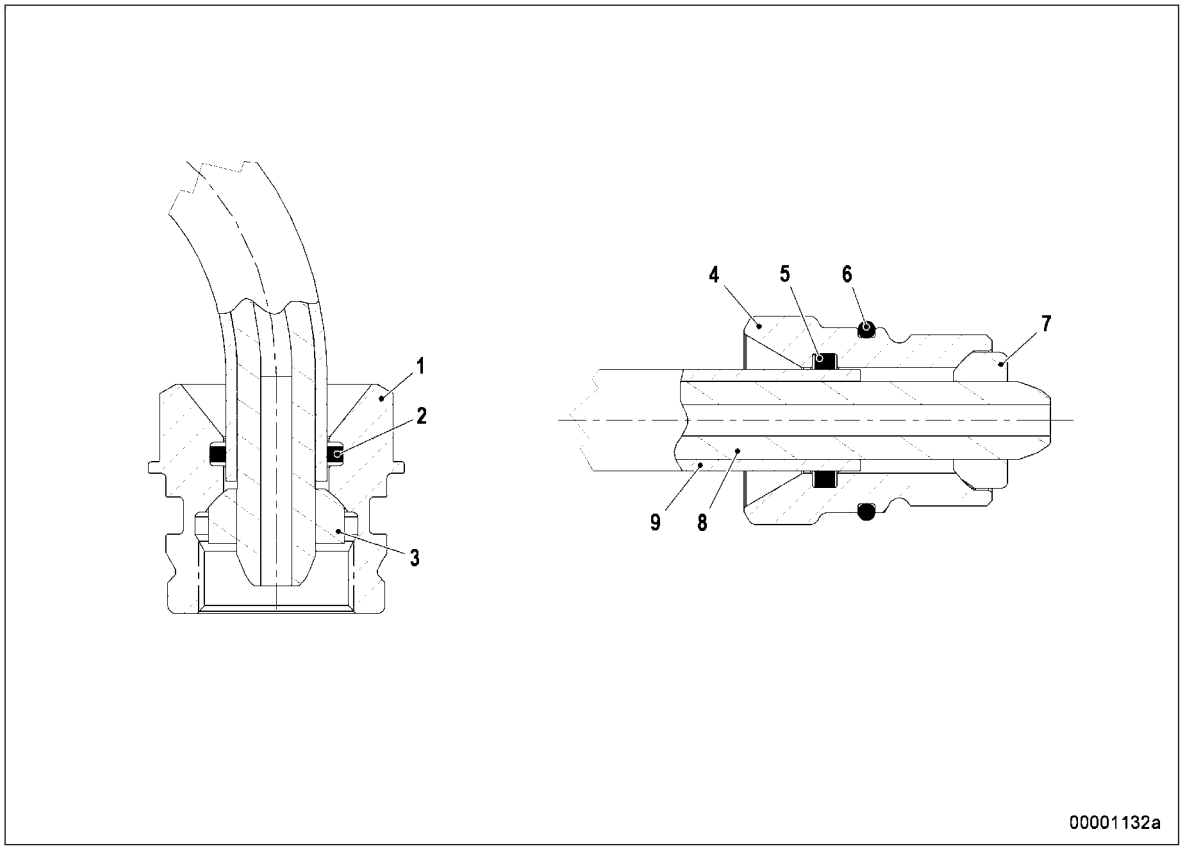
HP line between fuel injector and HP accumulator



1 Support ring
2 V-ring
3 Thrust ring
4 Union nut
5 HP line
6 Thrust screw
7 Thrust ring
8 V-ring
9 Support ring

TIM-ID: 0000002177 - 002

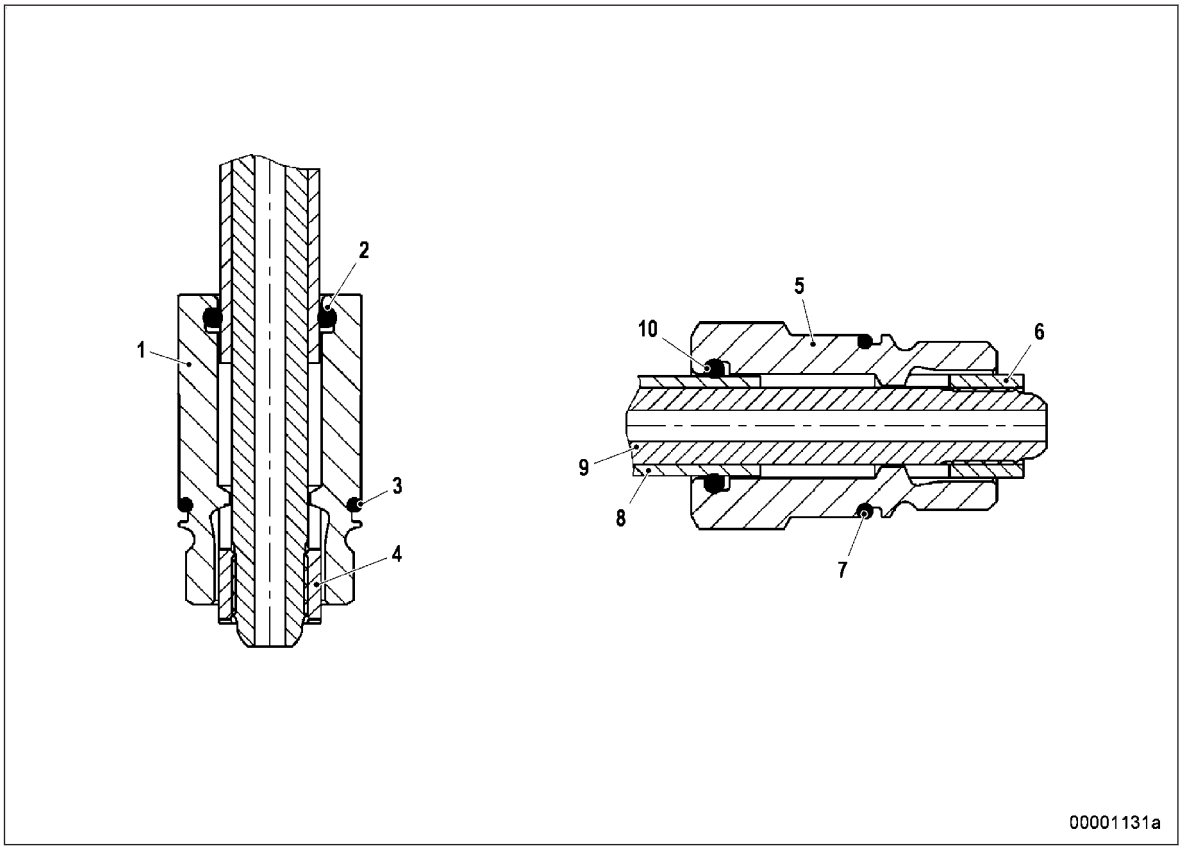
HP line between distributor and HP accumulator



1 Union nut
2 O-ring
3 Thrust ring
4 Thrust screw
5 O-ring
6 O-ring
7 Thrust ring
8 Pressure pipe
9 Jacket pipe

TIM-ID: 0000002177 - 002

HP line between distributor and HP accumulator



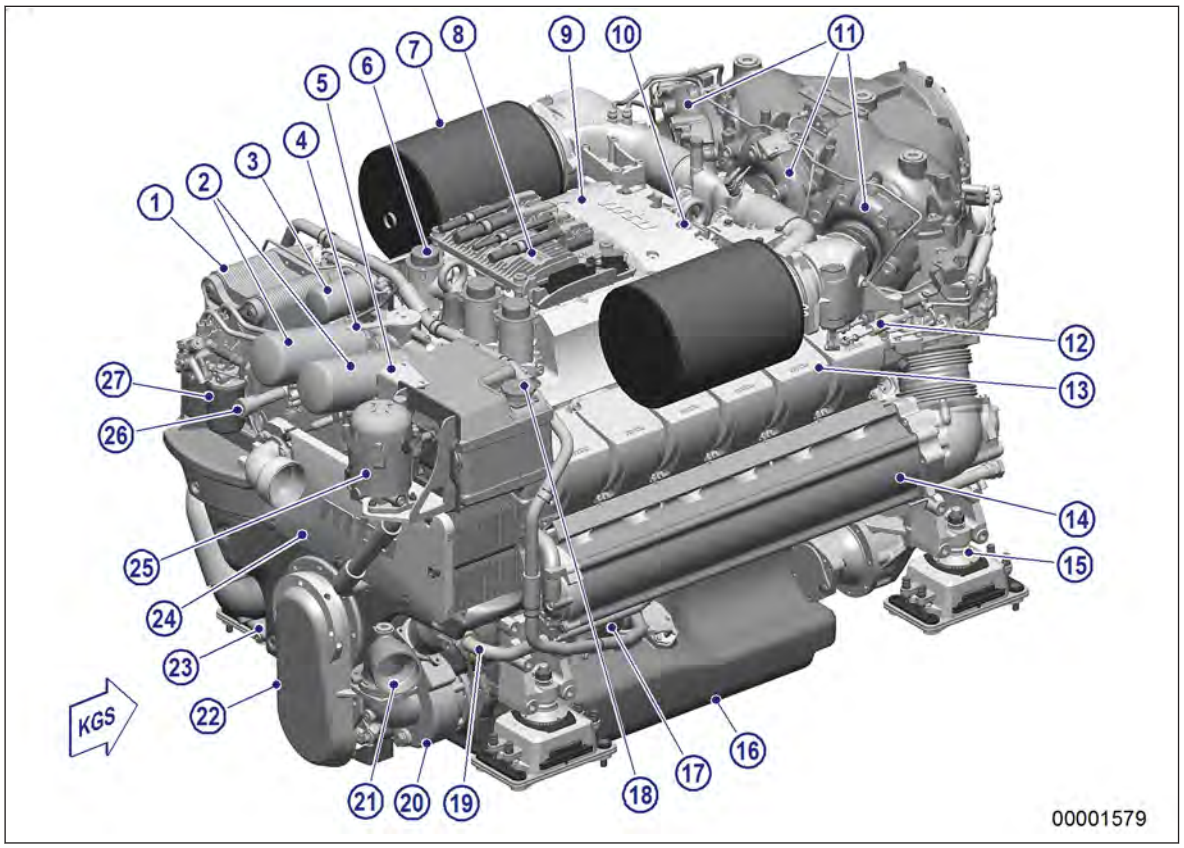
1 Jacket pipe
2 O-ring
3 O-ring
4 Thrust ring
5 Thrust screw
6 Thrust ring
7 O-ring
8 HP line
9 Pressure pipe
10 O-ring

Leak fuel caused by leakages from the sealing cones or the HP pump, from where it is routed at atmospheric pressure into a level-monitored leak fuel tank.

TIM-ID: 0000002177 - 002

2.4 Engine - Overview

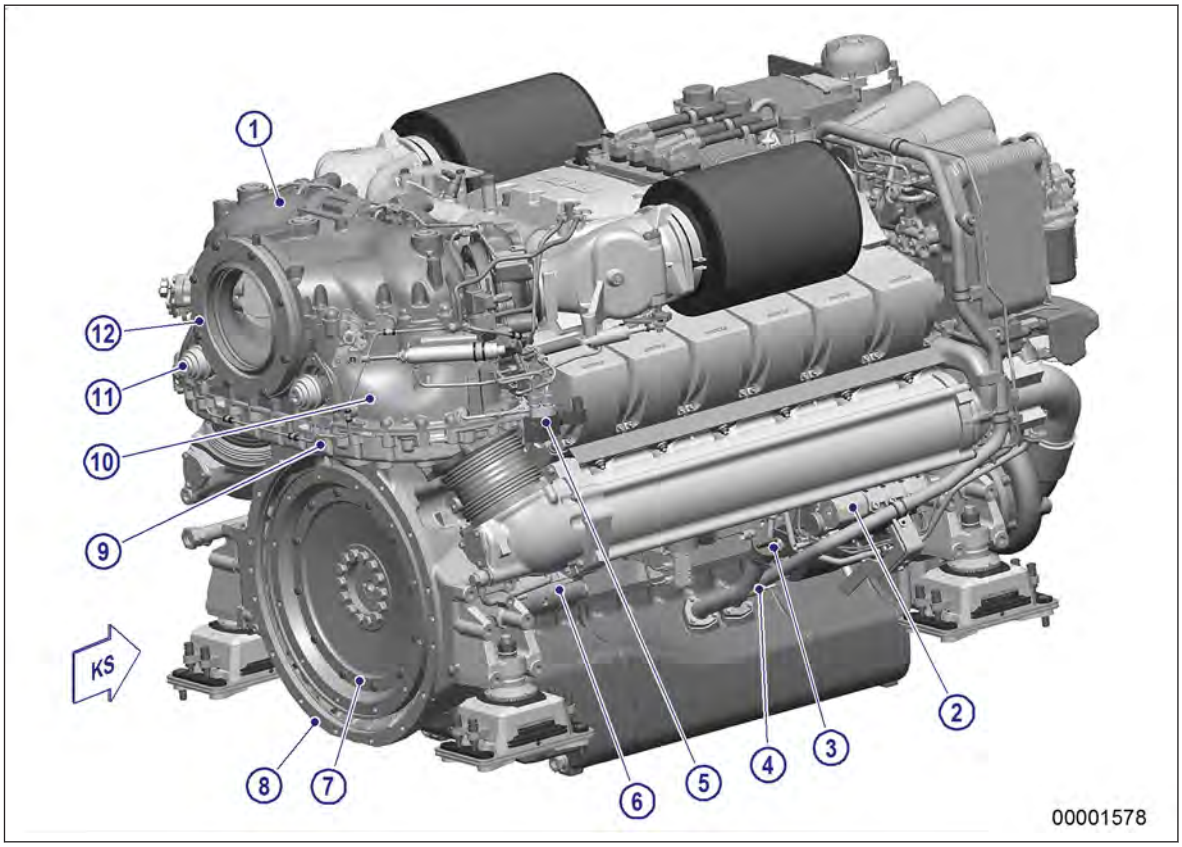
Overview of free end



1 Engine oil heat exchanger
2 Engine oil filter
3 Coolant filter
4 Diverter lever for engine oil filter
5 Coolant distribution housing with integrated expansion tank
6 Oil separator
7 Air filter (air intake)
8 Engine governor
9 Air collecting housing
10 Engine lifting eyes
11 Exhaust turbocharger
12 Actuating cylinder for exhaust flap
13 Carrier housing
14 Cylinder head cover
15 Engine mounting
16 Oil pan
17 Battery-charging generator
18 Coolant filler neck
19 Raw water connection to gearbox cooling system
20 Raw water pump
21 Raw water connection from sea
22 Protective cover (belt pulley)
23 Coolant pump
24 Plate-core heat exchanger
25 Centrifugal oil filter
26 Fuel priming pump
27 Fuel filter
KGS = engine free end

TIM-ID: 0000009987 - 003

Overview driving end



1 Carrier housing upper section
2 HP fuel pump
3 Oil filler neck
4 Oil dipstick
5 4/2-way directional control valve
6 Electric starter
7 Drive flange
8 Flywheel housing
9 Carrier housing lower section
10 Carrier housing middle section
11 Bleeder valve
12 Exhaust outlet
KS = engine driving end

Engine model designation

Key to the engine model designation 12V/16V 2000 Mxy	
12/16	Number of cylinders
v	Cylinder arrangement
2000	Series
Mx	Application segment
y	Design index

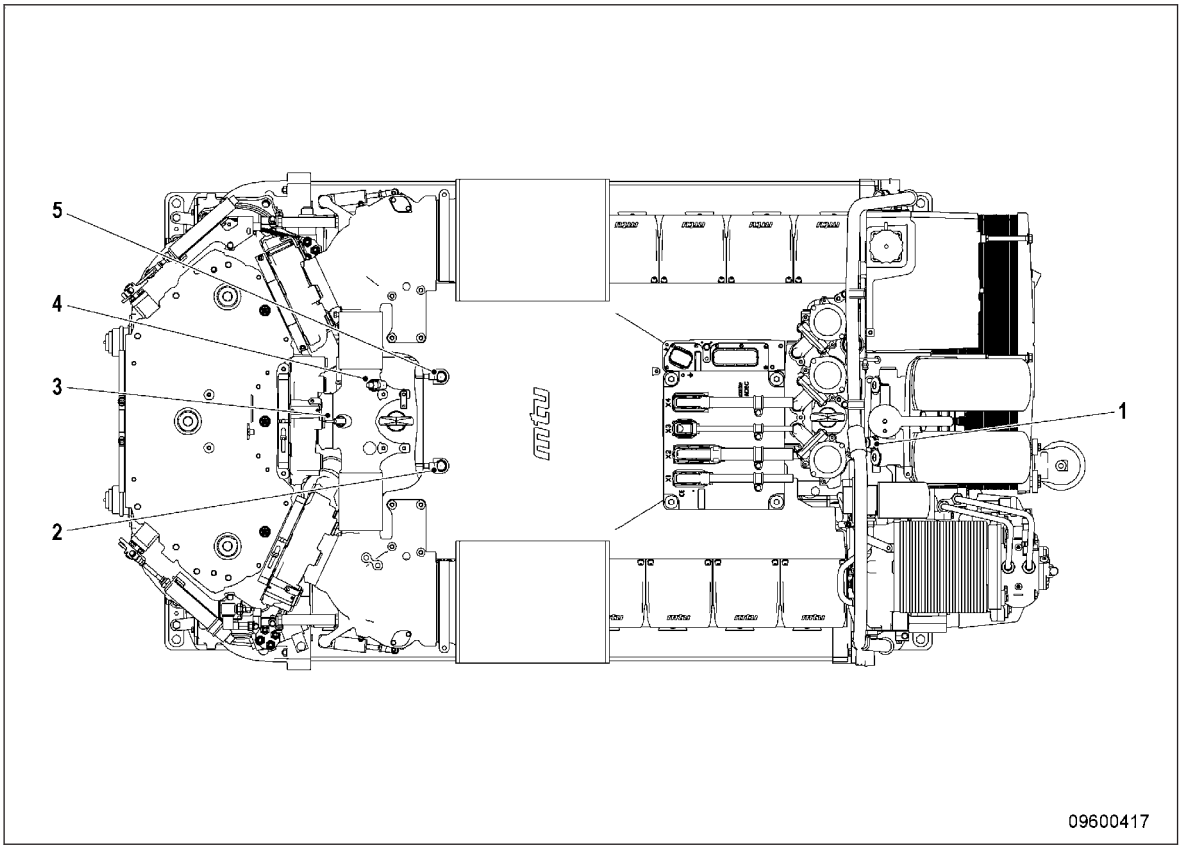
TIM-ID: 0000009987 - 003

2.5 Sensors, actuators and injectors – Overview

Engine plan view

Deviations from illustrations are insignificant.

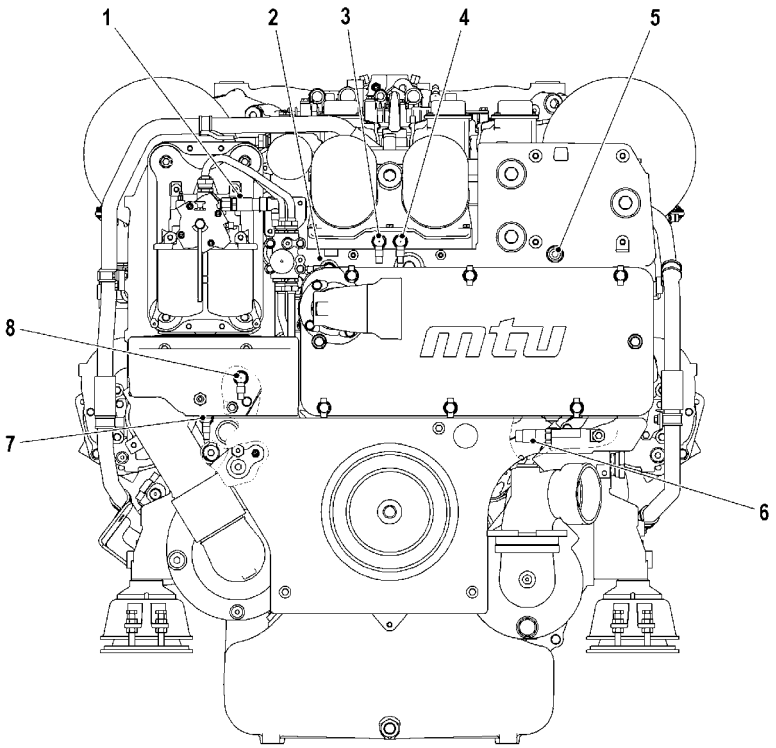
Also applies similarly to 12V.



Item	Description	Monitoring of
1	B7	Lube oil temperature
2	B10	Charge-air pressure
3	B44	Turbocharger speed
4	B3	Intake air temperature
5	B9	Charge-air temperature

TIM-ID: 0000008412 - 003

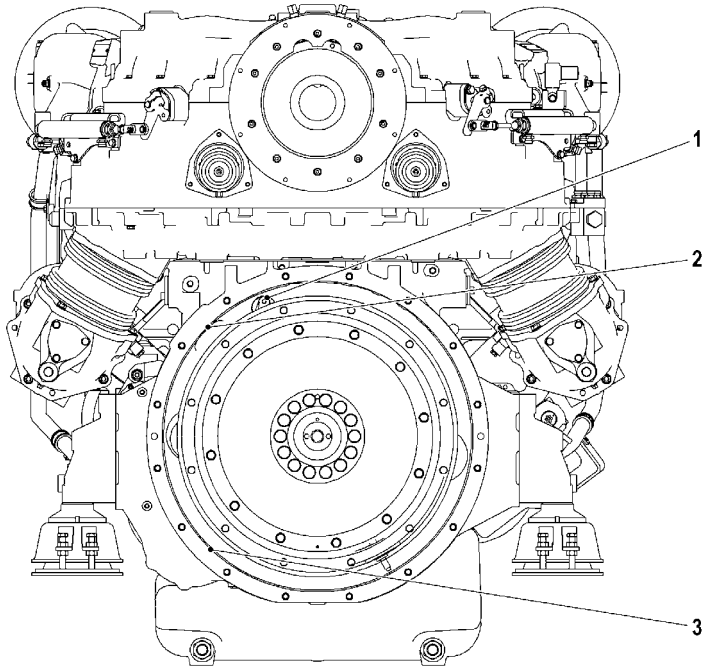
Engine free end



Item	Description	Monitoring of
1	B34	Fuel pressure after filter
2	B5.3 (option)	Lube oil pressure before filter
3	B5.1	Lube oil pressure after filter
4	B5.2 (option)	Lube oil pressure after filter
5	F33	Engine coolant level, expansion tank
6	B21 (option)	Raw water pressure
7	B6.2 (option)	Coolant temperature
8	B6.1	Coolant temperature

TIM-ID: 0000008412 - 003

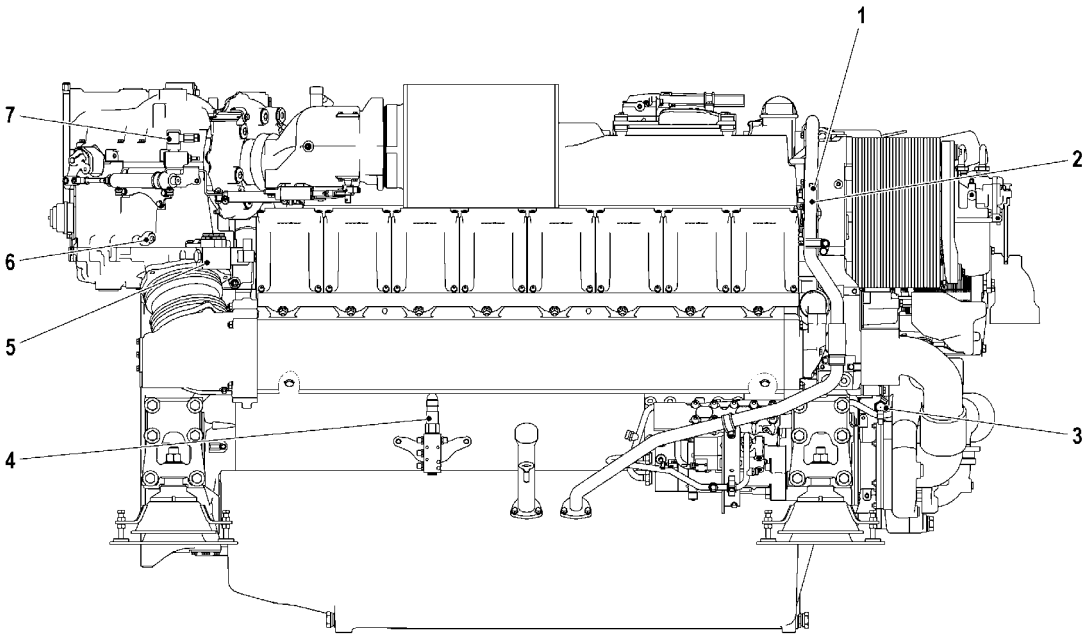
Engine driving end



Item	Description	Monitoring of
1	B1 (ECU)	Camshaft speed
2	B13.2 (optional EMU)	Crankshaft speed
3	B13 (ECU)	Crankshaft speed

TIM-ID: 0000008412 - 003

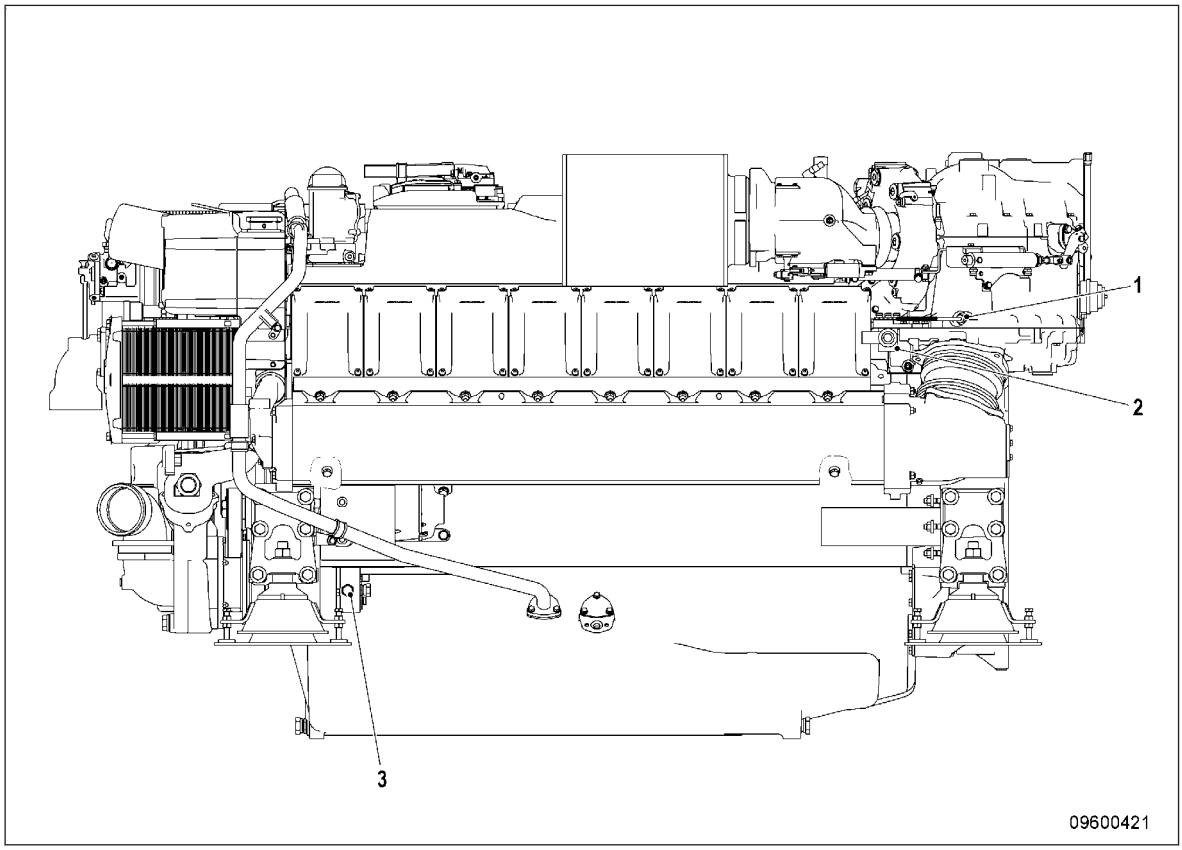
Engine, right side



Item	Description	Monitoring of
1	YB33	Fuel temperature
2	B48	Fuel pressure (in rail)
3	B16 (option)	Coolant pressure
4	F46	Leak fuel level
5	Y27.2	4-2-directional control valve, B-side
6	B4.22	Exhaust temperature, B-side
7	F41	2-2-directional control valve

TIM-ID: 0000008412 - 003

Engine, left side



Item	Description	Monitoring of
1	B4.21	Exhaust gas temperature, A-side
2	Y27.1	4-2-directional control valve, A-side
3	B54 (option)	Lube oil pressure, replenishment pump

System sensors

These sensors are fitted outside the engine.

Description	Monitoring of
B19	Starting-air pressure
B70	Fuel prefilter water level
B41	Exhaust back pressure
S37	Start interlock, switching status

TIM-ID: 0000008412 - 003

3 Technical Data

3.1 12V 2000 M94 engine data

Explanation:

CP Reference value: Continuous power
FP Reference value: Fuel stop power
A Design value
G Guaranteed value
R Guideline value
L Limit value, up to which the engine can be operated, without change (e.g. of power setting)
N Not yet defined value
- Not applicable
X Applicable

REFERENCE CONDITIONS

Engine model			12V2000 M94
Application group			1DS
Intake air temperature		°C	25
Raw water inlet temperature		°C	25
Barometric pressure		mbar	1000
Site altitude above sea level		m	100

POWER-RELATED DATA (power ratings are net brake power as per ISO 3046)

Number of cylinders			12
Rated engine speed	A	rpm	2450
Fuel stop power ISO 3046	A	kW	1432

GENERAL CONDITIONS (for maximum power)

Number of cylinders			12
Intake depression (new filter)	A	mbar	15
Intake depression, max.	L	mbar	30

MODEL RELATED DATA (basic design)

Number of cylinders			12
Cylinder arrangement: V angle		Degrees (°)	90
Bore		mm	135
Stroke		mm	156
Cylinder displacement		Liters	2.23
Displacement, total		Liters	26.76
Number of inlet valves per cylinder			2
Number of exhaust valves per cylinder			2

TIM-ID: 0000010852 - 002

RAW WATER CIRCUIT (open circuit)

Number of cylinders			12
Raw water pump: Inlet pressure, min.	L	bar	-0.4
Raw water pump: inlet pressure, max.	L	bar	+0.5
Pressure loss in engine-external raw water system, max.	L	bar	0.7

LUBE OIL SYSTEM

Number of cylinders			12
Lube oil operating temperature upstream of engine, from	R	°C	82
Lube-oil operating temperature upstream of engine, to	R	°C	92
Lube oil operating pressure upstream of engine, from	R	bar	7.5
Lube oil operating pressure upstream of engine, to	R	bar	8.5
Lube oil operating pressure (low idle) (meas. point: upstream of engine)	R	bar	3

FUEL SYSTEM

Number of cylinders			12
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.3
Fuel pressure at engine inlet connection, min. (when engine is running),	L	bar	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	+0.25
Fuel supply flow, max.	R	liters/min	7.1

GENERAL OPERATING DATA

Number of cylinders			12
Firing speed, from	R	rpm	100
Firing speed, to	R	rpm	120

STARTER (electric)

Number of cylinders			12
Rated starter voltage (standard design)	R	V=	24

INCLINATIONS, STANDARD OIL SYSTEM (reference: waterline)

Number of cylinders			12
Longitudinal inclination, continuous max. driving end down (Option: max. operating inclinations)	L	Degrees (°)	15
Longitudinal inclination, temporary max. driving end down (Option: max. operating inclinations)	L	Degrees (°)	22.5
Longitudinal inclination, continuous max. driving end up (Option: max. operating inclinations)	L	Degrees (°)	0
Longitudinal inclination, temporary max., driving end up (Option: max. operating inclinations)	L	Degrees (°)	10
Transverse inclination, continuous max. (Option: max. operating inclinations)	L	Degrees (°)	22.5
Transverse inclination, temporary max. (Option: max. operating inclinations)	L	Degrees (°)	32.5

TIM-ID: 0000010852 - 002

CAPACITIES

Number of cylinders			12
Engine coolant, engine side (with cooling system)	R	Liters	125
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	123
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	Liters	113
Oil pan capacity at dipstick mark “min.” (standard oil system) (Option: max. operating inclinations)	L	Liters	87
Oil pan capacity at dipstick mark “max.” (standard oil system) (Option: max. operating inclinations)	L	Liters	105

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			12
Engine dry weight (with attached standard accessories, without coupling)	R	kg	2780

NOISE

Number of cylinders			12
Exhaust noise, unsilenced - BL (free-field sound pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	109
Engine surface noise with attenuated intake noise (filter) - BL (free-field sound power level Lp, 1 m distance, ISO 6798, +2dB(A) tolerance)	R	dB(A)	104

TIM-ID: 0000010852 - 002

3.2 16V 2000 M94 engine data

Explanation:

CP Reference value: Continuous power
FP Reference value: Fuel stop power
A Design value
G Guaranteed value
R Guideline value
L Limit value, up to which the engine can be operated, without change (e.g. of power setting)
N Not yet defined value
- Not applicable
X Applicable

REFERENCE CONDITIONS

Engine model			16V2000 M94
Application group			1DS
Intake air temperature		°C	25
Raw water inlet temperature		°C	25
Barometric pressure		mbar	1000
Site altitude above sea level		m	100

POWER-RELATED DATA (power ratings are net brake power as per ISO 3046)

Number of cylinders			16
Rated engine speed	A	rpm	2450
Fuel stop power ISO 3046	A	kW	1939

GENERAL CONDITIONS (for maximum power)

Number of cylinders			16
Intake depression (new filter)	A	mbar	15
Intake depression, max.	L	mbar	30

MODEL RELATED DATA (basic design)

Number of cylinders			16
Cylinder arrangement: V angle		Degrees (°)	90
Bore		mm	135
Stroke		mm	156
Cylinder displacement		Liters	2.23
Displacement, total		Liters	35.68
Number of inlet valves per cylinder			2
Number of exhaust valves per cylinder			2

TIM-ID: 0000010887 - 002

RAW WATER CIRCUIT (open circuit)

Number of cylinders			16
Raw water pump: Inlet pressure, min.	L	bar	-0.4
Raw water pump: inlet pressure, max.	L	bar	+0.5
Pressure loss in engine-external raw water system, max.	L	bar	0.7

LUBE-OIL SYSTEM

Number of cylinders			16
Lube oil operating temperature upstream of engine, from	R	°C	75
Lube-oil operating temperature upstream of engine, to	R	°C	94
Lube oil operating pressure upstream of engine, from	R	bar	6.0
Lube oil operating pressure upstream of engine, to	R	bar	7.5
Lube oil operating pressure (low idle) (meas. point: upstream of engine)	R	bar	2.5

FUEL SYSTEM

Number of cylinders			16
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.3
Fuel pressure at engine inlet connection, min. (when engine is running),	L	bar	-0.3
Fuel pressure at engine inlet connection, max. (when engine is starting)	L	bar	+0.25
Fuel supply flow, max.	R	liters/min	8.6

GENERAL OPERATING DATA

Number of cylinders			16
Firing speed, from	R	rpm	100
Firing speed, to	R	rpm	120

STARTER (electric)

Number of cylinders			16
Rated starter voltage (standard design)	R	V=	24

INCLINATIONS, STANDARD OIL SYSTEM (reference: waterline)

Number of cylinders			16
Longitudinal inclination, continuous max. driving end down (Option: max. operating inclinations)	L	Degrees (°)	15
Longitudinal inclination, temporary max. driving end down (Option: max. operating inclinations)	L	Degrees (°)	22.5
Longitudinal inclination, continuous max. driving end up (Option: max. operating inclinations)	L	Degrees (°)	0
Longitudinal inclination, temporary max., driving end up (Option: max. operating inclinations)	L	Degrees (°)	10
Transverse inclination, continuous max. (Option: max. operating inclinations)	L	Degrees (°)	22.5
Transverse inclination, temporary max. (Option: max. operating inclinations)	L	Degrees (°)	32.5

TIM-ID: 0000010887 - 002

CAPACITIES

Number of cylinders			16
Engine coolant, engine side (with cooling system)	R	Liters	135
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	168
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	Liters	155
Oil pan capacity at dipstick mark “min.” (standard oil system) (Option: max. operating inclinations)	L	Liters	115
Oil pan capacity at dipstick mark “max.” (standard oil system) (Option: max. operating inclinations)	L	Liters	138

WEIGHTS / MAIN DIMENSIONS

Number of cylinders			16
Engine dry weight (with installed standard accessories, without coupling)	R	kg	3337

NOISE

Number of cylinders			16
Exhaust noise, unsilenced - BL (free-field sound pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	110
Engine surface noise with attenuated intake noise (filter) - BL (free-field sound power level Lp, 1 m distance, ISO 6798, +2dB(A) tolerance)	R	dB(A)	107

TIM-ID: 0000010887 - 002

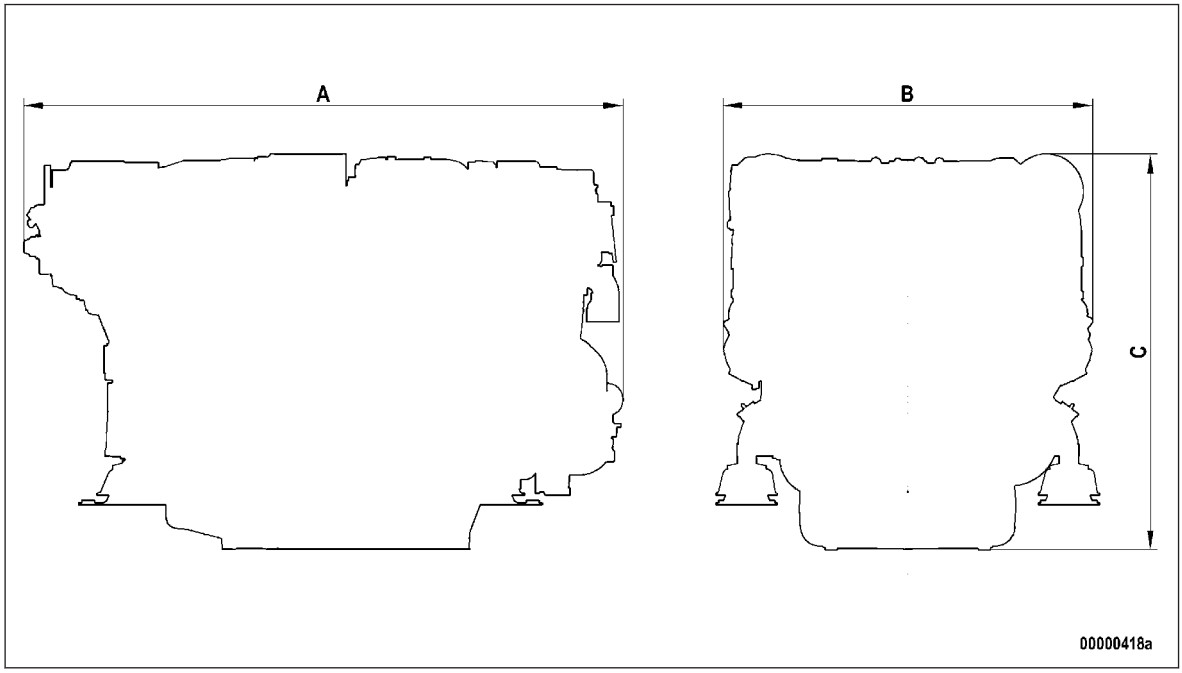
3.3 Firing order

Firing order	
12 V	A1-B5-A5-B3-A3-B6-A6-B2-A2-B4-A4-B1
16 V	A1-B5-A3-A5-B2-B8-A2-A8-B3-A7-B4-B6-A4-A6-B1-B7

TIM-ID: 0000038135 - 001

3.4 Engine – Main dimensions

Main dimensions



Engine model	Length (A)	Width (B)	Height (C)
12V 2000 M92	approx. 2069 mm	approx. 1295 mm	approx. 1350 mm
12V 2000 M93	approx. 2069 mm	approx. 1295 mm	approx. 1350 mm
12V 2000 M84	approx. 2094 mm	approx. 1295 mm	approx. 1350 mm
12V 2000 M94	approx. 2094 mm	approx. 1295 mm	approx. 1350 mm
16V 2000 M92	approx. 2486 mm	approx. 1295 mm	approx. 1390 mm
16V 2000 M93	approx. 2486 mm	approx. 1295 mm	approx. 1390 mm
16V 2000 M84	approx. 2511 mm	approx. 1295 mm	approx. 1390 mm
16V 2000 M94	approx. 2511 mm	approx. 1295 mm	approx. 1390 mm

TIM-ID: 0000038137 - 001

4 Operation

4.1 Putting the engine into operation after extended out-of-service periods (>3 months)

Preconditions

☑ Engine is stopped and starting disabled.

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Putting the engine into operation (out-of-service period > 3 months)

Item	Measure
Engine	Depreserve (→ MTU Fluids and Lubricants Specifications A001061/..).
Lube oil system	Check engine oil level (→ Page 105).
Fuel prefilter	Fill with fuel (→ Page 98).
Fuel prefilter, pressure gauge	Align adjustable pointer with position of pressure indicator (→ Page 94).
Fuel system	Vent (→ Page 91).
Raw-water pump (if located above waterline)	Prime (approx. 3 to 4 liters). Filling point (→ Page 112).
Coolant circuit	If engine is out of service for more than one year, change engine coolant (→ Page 118).
Coolant circuit	Check coolant level (→ Page 117).
Coolant circuit	Heat engine coolant with coolant preheating unit.

TIM-ID: 0000002213 - 002

4.2 Engine – Putting into operation after scheduled out-of-service-period

Preconditions

☑ Engine is stopped and starting disabled.

Putting into operation

Item	Measure
Lube oil system	Check engine oil level (→ Page 105).
Coolant circuit	Check coolant level (→ Page 117).
Coolant circuit	Heat engine coolant with coolant preheating unit.
Fuel prefilter	Drain water and contaminants (→ Page 95).
Battery-charging generator drive	Check condition of drive belt (→ Page 125).

TIM-ID: 0000002689 - 002

4.3 Tasks after extended out-of-service periods (>3 weeks)

Tasks after extended out-of-service periods (>3 weeks)

Note: Operate fuel treatment system for at least 5 minutes.

1. Start up fuel treatment system (→ Page 53).
2. Shut down fuel treatment system (→ Page 61).

TIM-ID: 0000007730 - 005

4.4 Checks prior to start-up

Checks prior to start-up

1. Check tank and the entire pipework for cleanness. If microorganisms are detected:
   a) Clean affected components.
   b) Disinfect affected components with biocides (→ MTU Fluids and Lubricants Specifications A001061/..).
2. Close drain valves on housing.
3. Open all supply and discharge valves.
4. Switch on fuel treatment system (→ Page 56).
5. Check direction of rotation of pump.
6. Vent bypass and fuel lines of the system.
   a) Open ball valve for pressure tank.
   b) Open ball valve for overflow tank.
   c) Close ball valve at the inlet to the fuel treatment system.

Result: Bypass line is vented via the overflow tank.

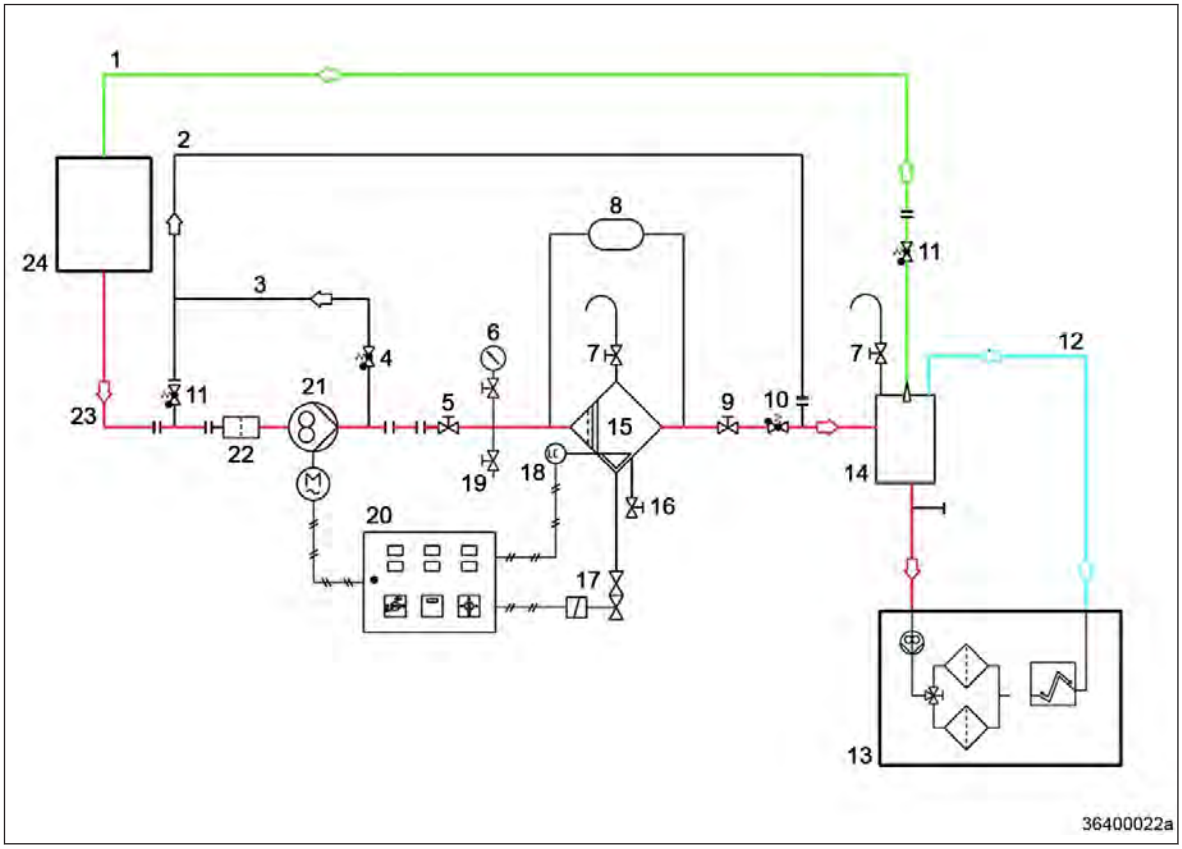
   d) Open ball valve at the inlet to the fuel treatment system.
7. Check the fuel treatment system for leaks.

Result: The fuel treatment system is ready for operation.

TIM-ID: 0000007736 - 005

4.5 Fuel treatment system – Putting into operation

Fuel treatment system – Overview



1. Switch on fuel treatment system (→ Page 56).
2. Check the differential pressure at differential pressure gauge (8). Differential pressure in a new system: 0.1 bar to 0.3 bar.

Result: If no differential pressure is measured, the coalescer filter element is probably being bypassed.
1. Remove coalescer filter element (→ Page 131).
2. Check sealing faces on coalescer filter element and in the pressure tank.

Initial operation: HAT

1. Replace fuel filter on engine (→ Page 92).

Note: Determine the suction pressure upstream of the engine-mounted fuel delivery pump.
2. Install a pressure gauge in the fuel supply line from the shipyard-side fuel system to the engine.
3. Switch on fuel treatment system and operate it for some minutes (→ Page 56).

Result: Fuel is sucked from the tank, dirt particles and water are filtered and separated, then the fuel is delivered via the overflow tank back to the tank. Water which has settled in the tank is separated.
4. Start engine (→ Page 57).
5. Run engine at idling speed.
6. Check suction pressure (see technical data of the engine) at the engine-mounted fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory:
7. Increase engine speed to 1000 rpm and monitor suction pressure.
8. Check suction pressure at the engine-mounted fuel delivery pump.

Result: If the values are within the limits specified by the manufacturer, the system is ready to start filter replacement simulation with the engine running as part of the Harbor Acceptance Tests.

TIM-ID: 0000007738 - 005

Simulation of filter replacement with the engine running: HAT

1. Switch on fuel treatment system (→ Page 56).
2. Start engine (→ Page 57).
3. Run engine at idling speed.
4. Close ball cock (5) at the inlet to the fuel treatment system.

Result: The pressure upstream of the fuel treatment system increases until the overflow valve at the pump unit opens and fuel flows through bypass (3) and bypass (2).

5. Open ball cock (19).

Result: Fuel emerges. If no fuel emerges:
- Open ball cock (5) at the inlet to the fuel treatment system.
- No function of bypasses (2) and (3); carry out functional test of bypasses (2) and (3).

6. Check suction pressure (see technical data of the engine) at the fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory:

7. Increase engine speed to 1000 rpm and monitor suction pressure.

Result: If all engine operating values are within the specified limits, open ball cock (5) at the inlet to the fuel treatment4 system.

Simulation of power failure (emergency): HAT

1. Switch on fuel treatment system (→ Page 56).
2. Start engine (→ Page 57).
3. Run engine at idling speed.
4. Switch off pump (21) on switch cabinet.

Result: The engine-mounted fuel delivery pump sucks fuel via bypass (2) directly from the tank.

5. Check suction pressure at the engine-mounted fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory.

6. Increase engine speed to 1000 rpm and monitor suction pressure.

Result: If the suction pressure is within the specified limits, simulation was successful.

Simulation of power failure (emergency): SAT

1. Switch on fuel treatment system (→ Page 56).
2. Start engine (→ Page 57).
3. Run engine at idling speed.
4. Switch off pump (21) on switch cabinet.

Result: The engine-mounted fuel delivery pump sucks fuel via bypass (2) directly from the tank.

5. Check suction pressure at the engine-mounted fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory:

6. Operate engine at full load and monitor suction pressure.

Result: If the suction pressure is within the specified limits, simulation was successful.

TIM-ID: 0000007738 - 005

4.6 Operational checks

DANGER

Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

WARNING

Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.

Operational checks

Item	Measure
Engine under load	Visually inspect engine for leaks and general condition;
Engine at nominal speed	Check for abnormal running noises and vibration;
	Check exhaust color (→ Page 65).
Fuel prefilter	Check fuel prefilter contamination indicator for max. admissible value (→ Page 94).
	Drain water and contaminants (→ Page 95).
Air filter	Check signal ring position of contamination indicator (→ Page 103).
HT coolant pump	Check relief bore for oil and coolant discharge and contamination (→ Page 121).
Raw water pump	Check relief bore for oil and water discharge and contamination (→ Page 124).
Intercooler	Check condensate drain (if applicable) (→ Page 100).
Engine oil	Check engine oil level (→ Page 105).

TIM-ID: 0000002274 - 005

4.7 Fuel treatment system – Switching on

Preconditions

☑ The on-board power supply is switched on.

CAUTION

Damage to engine/plant.
Major material damage!
- Before switching on, ensure that the engine/plant is ready for operation.
- Before switching on, ensure that all housings are closed.
- Before switching on, ensure that no work is in progress anywhere on the entire system.

Switching on fuel treatment system

1. Carry out checks prior to start-up (→ Page 52).
2. Switch on master switch on switch cabinet.

Result: Signal lamp “Control voltage present” lights up.

3. Switch on switch for pump.

Result: Signal lamp “Pump running” lights up.

TIM-ID: 0000007731 - 005

4.8 Starting the engine

Preconditions

☑ External start interlock is not active.

☑ Emergency air shut-off flaps (if fitted) are open.

DANGER

Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Before barring or starting the engine, make sure that nobody is in the danger zone.

WARNING

Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.

The engine can be started from the following points

Item	Action
Control stand	(→ Operating instructions for electronic system)
Local Operating Panel LOP	(→ Operating instructions for electronic system)
Local Operation Station LOS	(→ Operating instructions for electronic system)
CCU	(→ Operating instructions for electronic system)

TIM-ID: 0000002240 - 003

4.9 Stopping the engine

Preconditions

☑ Engine is running in local mode.

CAUTION

Stopping the engine when it is running at full load causes extreme stress to the engine.
Risk of overheating, damage to components!

- Before shutting down, disengage gear and run the engine at idle speed for at least 10 mins. until engine temperatures have dropped and constant values are displayed.

The engine can be stopped from the following points :

1. (→ Operating instructions for electronic system)
2. Commanding control stand (→ Operating instructions for electronic system);
3. Local operating panel LOP (→ Operating instructions for electronic system);
4. Local Operation Station LOS (→ Operating instructions for electronic system);
5. CCU (→ Operating instructions for electronic system).

TIM-ID: 0000002298 - 002

4.10 Emergency stop

CAUTION

An emergency stop causes extreme stress to the engine.
Risk of overheating, damage to components!
- Initiate emergency stop only in emergency situations.

An emergency stop of the engine can be initiated from the following points :

1. (→ Operating instructions for electronic system)
2. Commanding control stand (→ Operating instructions for electronic system);
3. Local operating panel LOP (→ Operating instructions for electronic system);
4. Local Operation Station LOS (→ Operating instructions for electronic system);
5. CCU (→ Operating instructions for electronic system).

TIM-ID: 0000002312 - 002

4.11 After stopping the engine

Preconditions

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

After stopping the engine

Item	Action
Coolant circuit	Drain coolant (→ Page 119) if: • freezing temperatures are expected and the engine is to remain out of service for an extended period, but engine coolant has no antifreeze additive; • the engine room is not heated; • the coolant is not kept at a suitable temperature; • the antifreeze concentration is insufficient for the engine-room temperature; • antifreeze concentration is 50 % and engine-room temperature is below -40 °C.
Raw water	Drain • If freezing temperatures are to be expected and the engine is to remain out of service for an extended period.
Engine control system	Switch off.
Air intake and exhaust system	Out-of-service-period > 1 week • Seal engine's air and exhaust sides.
Engine	Out-of-service-period > 1 month • Preserve engine (→ MTU Fluids and Lubricants Specifications A001061/..)

TIM-ID: 0000002324 - 007

4.12 Fuel treatment system – Shutdown

Shutting down fuel treatment system

1. Press the illuminated pushbutton "Water drain" on the switch cabinet until water discharge from the outlet stops.
2. Switch off fuel treatment system.
3. Close ball valve at the inlet to the fuel treatment system.
4. Close ball valve at the outlet of the fuel treatment system.
5. Open drain valve until pressure has escaped from fuel treatment system.

TIM-ID: 0000007732 - 005

4.13 Plant cleaning

Preconditions

☑ Engine is stopped and starting disabled.

☑ Operating voltage is not present.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Steam jet cleaner	-	1
Cleaner (Hakupur 312)	30390	1

WARNING

Compressed air
Risk of injury!
- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

WARNING

Water jet.
Risk of injury and scalding!
- Do not direct water jet at persons.
- Wear protective clothing, gloves, and goggles / safety mask.

CAUTION

Excessive reaction time of cleaning agents on components.
Damage to component!
- Observe manufacturer's instructions.
- Wear protective clothing, gloves, and goggles / safety mask.

NOTICE

Dry with compressed air.
Damage to component!
- Never aim compressed air directly at electronic components.

Plant cleaning

1. Carry out plant cleaning only in areas where an appropriate oil separator is provided (environmental protection).
2. Prior to putting the cleaning unit into operation, read the Operating Instructions of the water/steam jet unit carefully and observe the safety precautions.
3. During external cleaning of the plant with water/steam-jet units, the pressure of the high-pressure jet (cleaning jet) must not exceed 50 bar. A minimum distance between spray nozzle and plant of 1 m must be observed. The temperature of the cleaning medium must not exceed 80 °C.
4. For external cleaning with high-pressure jet, use a flat-mouth nozzle only.
5. Carry out external cleaning as follows:
   a) Seal all openings in a suitable fashion.
   b) Remove coarse dirt.
   c) Spray on cleaner sparingly and leave it for 1 to 5 minutes.
   d) Use the high-pressure jet to remove the loosened dirt.

Note: Never aim compressed air directly at electronic components.

   e) Dry engine.

TIM-ID: 0000010171 - 024

5 Maintenance

5.1 Maintenance task reference table [QL1]

The maintenance tasks and intervals for this product are defined in the Maintenance Schedule. The Maintenance Schedule is a stand-alone publication.

The task numbers in this table provide reference to the maintenance tasks specified in the Maintenance Schedule.

Task	Maintenance tasks	
W0500	Check engine oil level	(→ Page 105)
W0501	Visually inspect engine for leaks and general condition	(→ Page 55)
W0502	Check intercooler drain (if fitted)	(→ Page 100)
W0503	Check signal ring position of service indicator on air filter	(→ Page 103)
W0505	Check relief bores of coolant pump(s)	(→ Page 121)
W0506	Check engine for abnormal running noises, exhaust color and vibrations	(→ Page 55)
W0507	Drain water and contaminants from fuel prefilter (if fitted)	(→ Page 95)
W0508	Check reading on differential pressure gauge of fuel prefilter (if fitted)	(→ Page 94)
W1001	Replace fuel filter or fuel filter element	(→ Page 92)
W1002	Check valve clearance	(→ Page 84)
W1005	Replace air filter	(→ Page 101)
W1006	Replace fuel injectors	(→ Page 88)
W1008	Replace engine oil filter at each oil change or when the time limit (years) is reached, at the latest	(→ Page 107)
W1009	Check layer thickness of oil residue, clean and replace filter sleeve (if fitted) at each oil change or when the time limit (years) is reached, at the latest	(→ Page 109)
W1011	Perform endoscopic inspection of combustion chambers	(→ Page 77)
W1036	Replace coolant filter	(→ Page 123)
W1140	Clean wire meshes of crankcase breather	(→ Page 81)
W1244	Check operation of rod electrode (if fitted)	(→ Page 129)
W1245	Check alarm function of differential pressure gauge (if fitted)	(→ Page 128)
W1246	Check pump capacity (if fitted)	(→ Page 130)

Table 1: Maintenance task reference table [QL1]

TIM-ID: 0000027582 - 003

6 Troubleshooting

6.1 Fuel treatment system – Troubleshooting

Illuminated pushbutton “water alarm” is lit.

Cause	Corrective action
When the maximum water level is reached, the water level electrode opens the water drain valve and water is discharged. If the opening period of the valve exceeds a pre-set limit (4 minutes), the pump will switch off and an alarm is initiated.	1. Press illuminated pushbutton “Water alarm” to acknowledge. 2. In addition to the automatic water drain function, water can also be drained manually. To do so, press the illuminated pushbutton “Water drain” to open the drain valve.

Signal lamp “Pump fault” is lit.

Cause	Corrective action
The drive motor is equipped with an overload protection. If the maximum permissible current consumption is exceeded, e.g. in case of a blockage or dry-running, the motor protection relay triggers and the pump is switched off.	▶ Reset motor protection relay.

Signal lamp “Warning filter” is lit.

Cause	Corrective action
The differential pressure exceeded 1.3 bar.	▶ Replace coalescer filter element (→ Page 131).

Illuminated pushbutton “Replace filter element” is lit.

Cause	Corrective action
The max. permissible differential pressure of 1.5 bar was exceeded. If the coalescer filter element is not replaced, pressure will increase further and the safety valve will open. Fuel will be led via the bypass directly into the overflow tank.	1. Replace coalescer filter element (→ Page 131). 2. Press illuminated pushbutton “Replace filter element” to acknowledge.

TIM-ID: 0000028607 - 001

6.2 Troubleshooting

Engine does not turn when starter is actuated

Component	Cause	Action
Battery	Low or faulty	Charge or replace (see manufacturer's documentation).
	Cable connections faulty	Check if cable connections are properly secured (see manufacturer's documentation).
Starter	Engine wiring or starter faulty	Check if cable connections are properly secured, contact Service.
Engine cabling	Faulty	Check (→ Page 133).
ECU	Plug-in connections possibly loose	Check plug connections for secure seating.
Engine	Running gear blocked (engine cannot be barred manually)	Contact Service.

Engine turns but does not fire

Component	Cause	Action
Starter	Poor rotation by starter:Battery low or faulty	Charge or replace battery (see manufacturer's documentation).
Engine cabling	Faulty	Check (→ Page 133).
Fuel system	Air in fuel system	Vent fuel system (→ Page 91)
ECU	Faulty	Contact Service.

Engine fires unevenly

Component	Cause	Action
Fuel injection equipment	Injector faulty	Replace (→ Page 88).
Engine cabling	Faulty	Check (→ Page 133).
Fuel system	Air in fuel system	Vent fuel system (→ Page 91)
ECU	Faulty	Contact Service.

Engine does not reach rated speed

Component	Cause	Action
Fuel supply	Fuel prefilter clogged	Replace (→ Page 98).
	Fuel filter clogged	Replace (→ Page 92).
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 103).
Fuel injection equipment	Injector faulty	Replace (→ Page 88).
Engine cabling	Faulty	Check (→ Page 133).
Engine	Overloaded	Contact Service.

TIM-ID: 0000002555 - 003

Engine speed not steady

Component	Cause	Action
Fuel injection equipment	Injector faulty	Replace (→ Page 88).
Speed sensor	Faulty	Replace.
Fuel system	Air in fuel system	Vent fuel system (→ Page 91)
ECU	Faulty	Contact Service.

Charge air temperature too high

Component	Cause	Action
Engine coolant	Engine coolant treatment incorrect	Check.
Intercooler	Contaminated	Contact Service.
Engine room	Air-intake temperature too high	Check fans and air supply / ventilation ducts.

Charge-air pressure too low

Component	Cause	Action
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 103).
Intercooler	Contaminated	Contact Service.
Exhaust turbocharger	Faulty	Contact Service.

Coolant leaks at intercooler

Component	Cause	Action
Intercooler	Leaking, major coolant discharge	Contact Service.

Black exhaust gas

Component	Cause	Action
Air supply	Air filter clogged	Check signal ring position of service indicator (→ Page 103).
Fuel injection equipment	Injector faulty	Replace (→ Page 88).
Engine	Overloaded	Contact Service.

Blue exhaust gas

Component	Cause	Action
Engine oil	Too much oil in engine	Drain engine oil (→ Page 106).
	Oil separator or oil-preseparator of crankcase breather clogged	• Clean preseparator (→ Page 81); • Replace oil separator element (→ Page 82).
Exhaust turbocharger, cylinder head, piston rings, cylinder liner	Faulty	Contact Service.

TIM-ID: 0000002555 - 003

White exhaust gas

Component	Cause	Action
Engine	Not at operating temperature	Run engine to reach operating temperature.
Fuel system	Water in fuel	Drain fuel prefilter (→ Page 95).
Intercooler	Leaking	Contact Service.

TIM-ID: 0000002555 - 003

7 Task Description

7.1 SOLAS

7.1.1 SOLAS shielding as per MTN 5233 – Installation

Preconditions

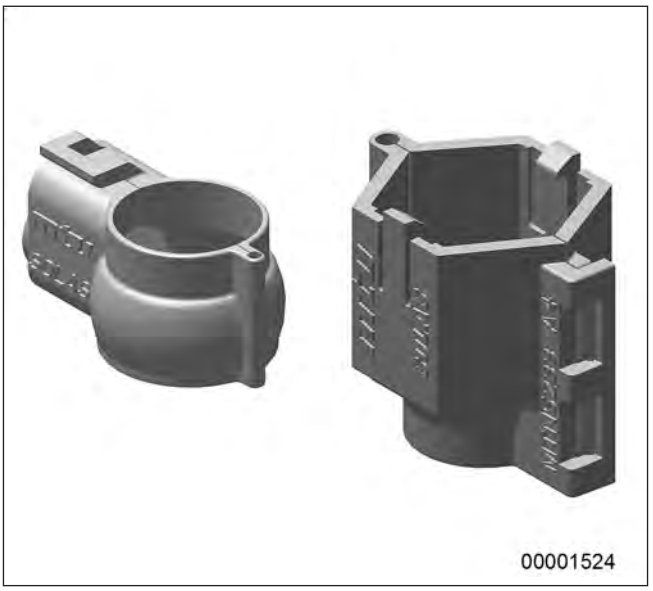
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Shield A4	735233000100	10
Shield A5	735233000101	14
Shield A7	735233000103	6
Shield A8	735233000104	2

SOLAS shielding – Installation

1. Pinpoint installation location (→ Page 70).
2. Install suitable shielding.
3. Press shielding until locked.



TIM-ID: 0000010550 - 003

7.1.2 SOLAS shielding – Installation

Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine is cooled down to ambient temperature.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Oil filter shield	X00009628	
Fuel filter shield	X00009654	

Installing SOLAS shield on oil filter and fuel filter

1. Pinpoint installation location (→ Page 70).
2. Install suitable shielding.

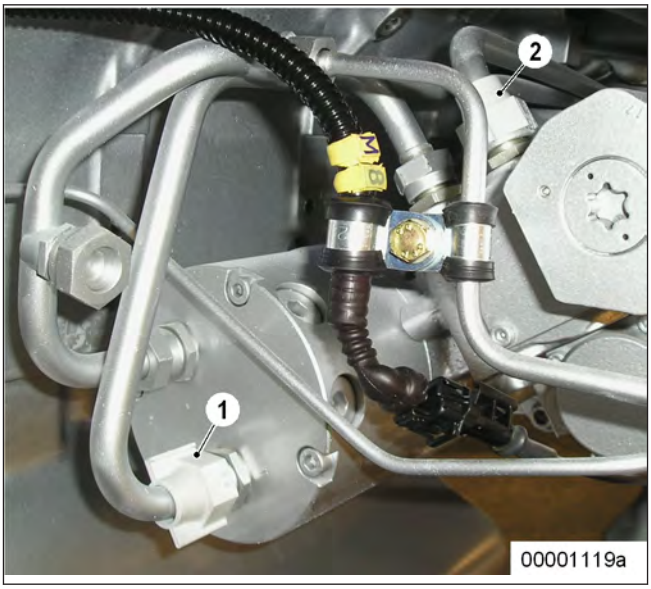
TIM-ID: 0000010702 - 005

7.1.3 Installation locations for SOLAS shielding

General information

Primarily fit SOLAS shielding as per MTN 5233 (→ Page 68).

Free end B-side



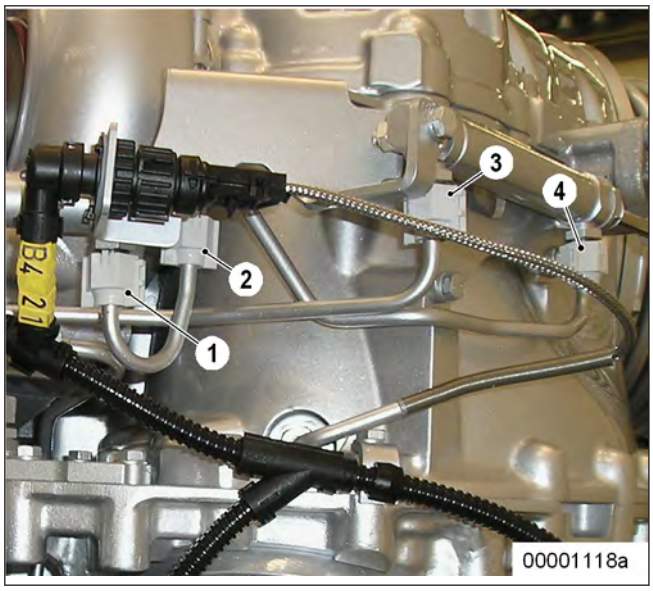
Item	Type of shielding	Comments
1 (free end, B-side)	Shield (A7)	On fuel delivery pump
2 (free end, B-side)	Shield (A7)	On HP fuel pump

Free end

TIM-ID: 0000010064 - 005

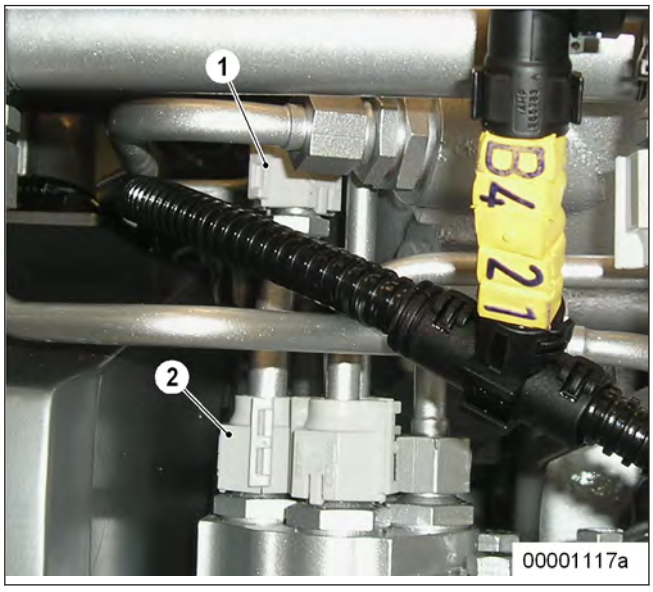
Item	Type of shielding	Comments
1 (free end)	Shield (A8)	On fuel filter
2 (free end)	Shield (A7)	Above fuel priming pump
3 (free end)	Shield (A7)	Below fuel priming pump

Driving end A-side



Item	Type of shielding	Comments
1 (Driving end, A-side)	Shield (A5)	On air flap
2 (Driving end, A-side)	Shield (A4)	On brazed-on union
3 (driving end, A-side)	Shield (A5)	On turbocharger flap
4 (driving end, A-side)	Shield (A5)	On turbocharger flap

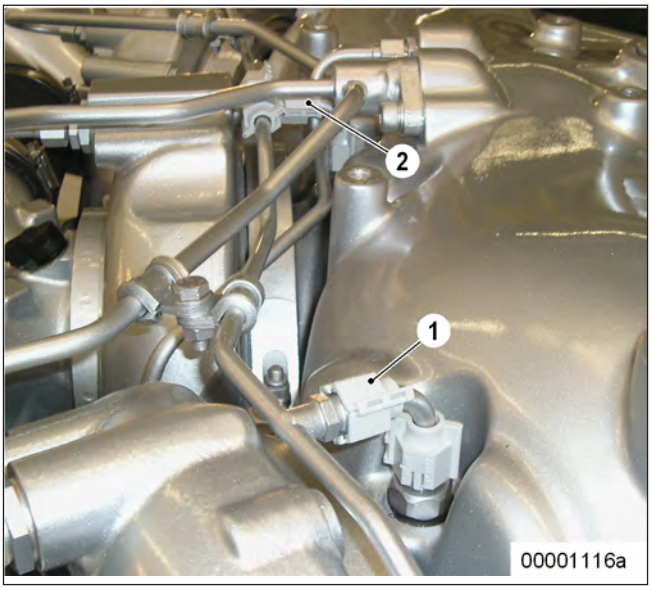
Driving end A-side



TIM-ID: 0000010064 - 005

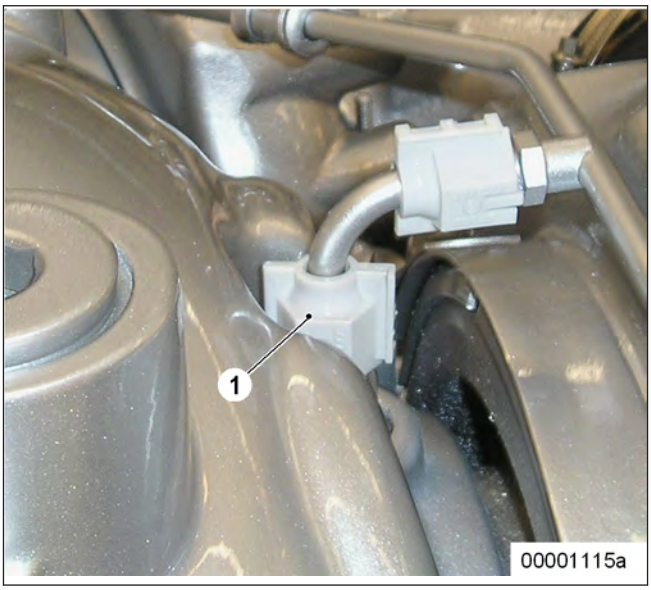
Item	Type of shielding	Comments
1 (driving end, A-side)	Shield (A5)	To turbocharger lubrication
2 (driving end, A-side)	Shield (A5)	On valve plate

Driving end



Item	Type of shielding	Comments
1 (driving end)	Shield (A4)	Turbocharger lubrication, left side
2 (driving end)	Shield (A4)	Turbocharger lubrication, center

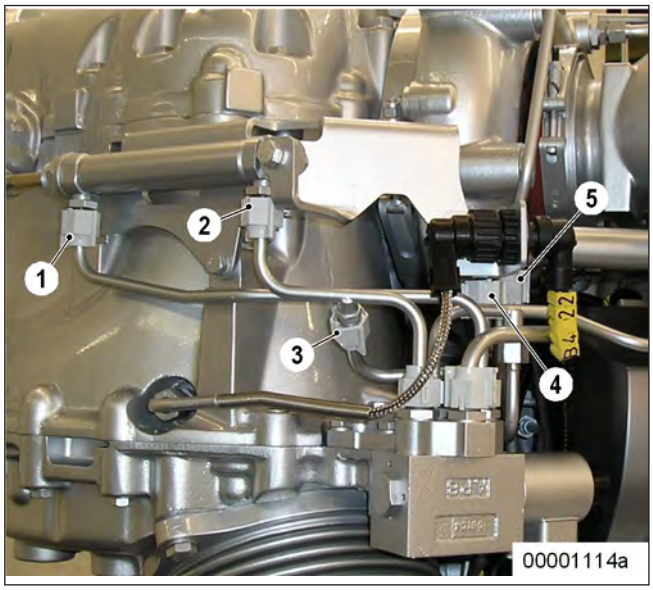
Driving end



Item	Type of shielding	Comments
1 (driving end)	Shield (A4)	Turbocharger lubrication, right side

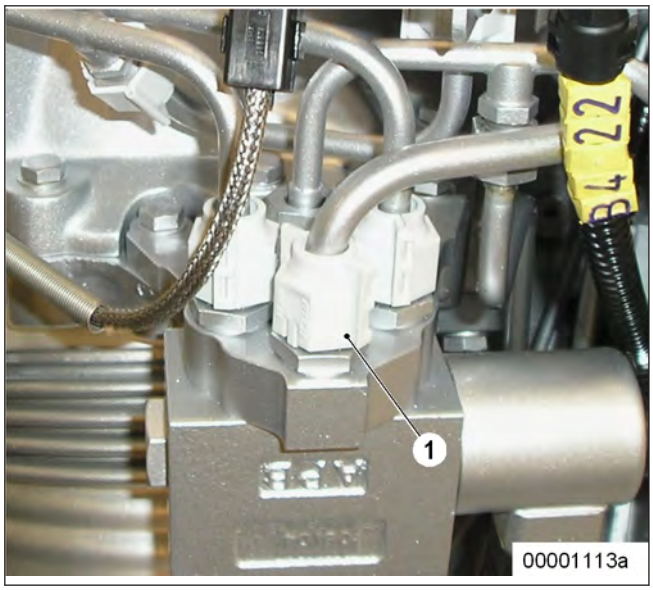
TIM-ID: 0000010064 - 005

Driving end B-side



Item	Type of shielding	Comments
1 (driving end, B-side)	Shield (A5)	Turbocharger flap
2 (driving end, B-side)	Shield (A5)	Turbocharger flap
3 (driving end, B-side)	Shield (A4)	On brazed-on union
4 (driving end, B-side)	Shield (A5)	On air flap
5 (driving end, B-side)	Shield (A4)	To turbocharger lubrication

Driving end B-side



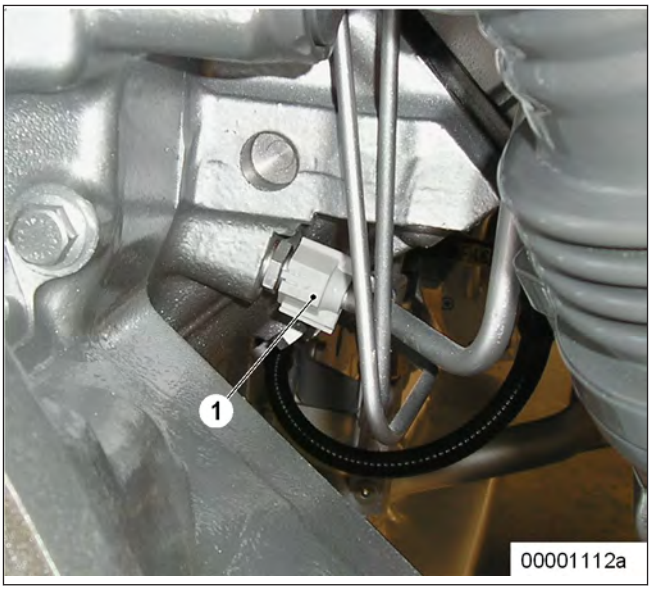
Item	Type of shielding	Comments
1 (driving end, B-side)	Shield (A5)	On valve plate

TIM-ID: 0000010064 - 005

Driving end A-side

Item	Type of shielding	Comments
1 (driving end, A-side)	Shield (A5)	To flap control

Driving end B-side



Item	Type of shielding	Comments
1 (driving end, B-side)	Shield (A5)	To flap control

TIM-ID: 0000010064 - 005

7.2 Engine

7.2.1 Engine – Barring manually

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Barring tool	F6783914	1
Ratchet	F30006212	1

DANGER

Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Before barring or starting the engine, ensure that nobody is in the danger zone.
- After working on the engine, check that all protective devices have been reinstalled and all tools removed from the engine.

Engine – Barring manually

1. Fit ratchet with barring tool on barring tool connection at the vibration damper on engine free end.
2. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no resistance.

Result: If the resistance exceeds the normal compression resistance, contact Service.

TIM-ID: 0000002527 - 002

7.2.2 Engine – Barring with starting equipment

Preconditions

☑ Clutch is disengaged.

☑ Engine start is disabled.

☑ LOP is accessible and open.

DANGER

Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!

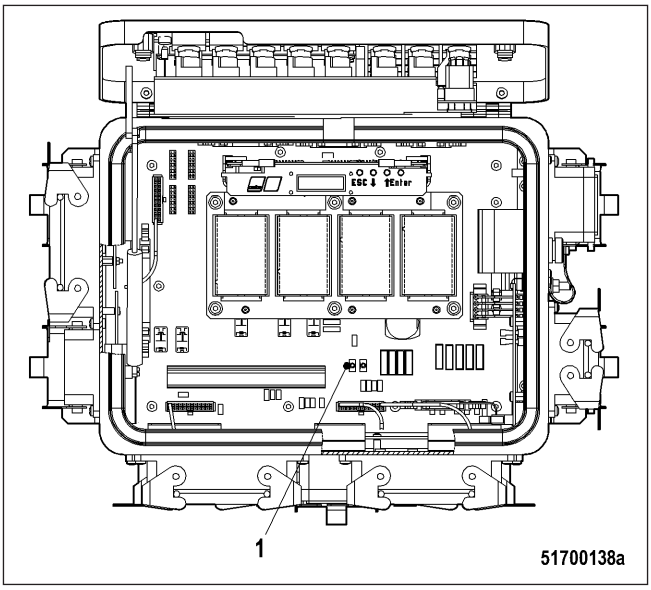
- Before barring or starting the engine, ensure that nobody is in the danger zone.
- After working on the engine, check that all protective devices have been reinstalled and all tools removed from the engine.

Barring

1. Press barring button on the LMB motherboard of the LOP and keep it depressed.

Result: Engine is barred by starter for max. 20 seconds.

2. Release barring pushbutton.



TIM-ID: 0000027968 - 001

7.3 Cylinder Liner

7.3.1 Cylinder liner – Endoscopic examination

Preconditions

☑ Engine is stopped and starting disabled

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Rigid endoscope	Y20097353	1

Preparatory steps

1. Remove cylinder head cover (→ Page 87).
2. Remove injector (→ Page 89).

Positioning crankshaft at BDC

1. Using barring gear, turn crankshaft until crankshaft journal of the cylinder to be inspected has reached BDC.
2. Insert endoscope into cylinder liner through injector seat.

Endoscopic examination of cylinder liner

Findings	Action
• Thin carbon coating on circumference of carbon scraper ring • Slight localized additive deposits at top edge • Localized smooth areas on bottom edge • Carbon deposits on circumference in clearance between top piston ring and bottom edge of carbon scraper ring • First signs of marks left by top piston ring • Bright mark on entire circumference • Consistent honing pattern without objections • First signs of marks left by lower cooling bores • Running pattern seems darker	No action required
• Dark areas with even or varying degrees of discoloration • Beginning and end of the discoloration are not sharply defined and do not cover the entire stroke area • Dark areas in the upper section of the cooling bore, remaining circumference without objections • Piston rings without objections	Further endoscopic examination required as part of maintenance work
• On the entire circumference, apart from light areas of discoloration (that do not impair operation) clearly darker stripes that start at the top piston ring • Heat discoloration in the direction of stroke and honing pattern damage • Heat discoloration of piston rings	Cylinder liner must be replaced; Service must be contacted

1. Compile endoscopy report using the table.
2. Use technical terms for description of the liner surface (→ Page 79).
3. Depending on findings:
   - do not take any action or
   - carry out a further endoscopic examination as part of maintenance work or
   - contact Service; cylinder liner must be replaced.

TIM-ID: 0000000015 - 013

Final steps

1. Install injector (→ Page 89).
2. Install cylinder head cover (→ Page 87).

TIM-ID: 0000000015 - 013

7.3.2 Cylinder liner – Instructions and comments on endoscopic and visual examination

Terms used for endoscopic examination

Use the terms listed below to describe the condition of the cylinder-liner surface in the endoscopic examination report.

Findings	Measure
Minor dirt scores	Minor dirt scores can occur during the assembly of a new engine (honing products, particles, broken-off burrs). Removed cylinders clearly show such scoring on the running surface under endoscope magnification. Cannot be felt with the fingernail. Findings not critical.
Single scores	Clearly visible scores caused by hard particles. They usually start in the TDC area and cross through the hone pattern in the direction of stroke. Findings not critical.
Scored area	These areas consist of scores of different length and depth next to one another. In most cases, they are found at the 6-o'clock and 12-o'clock positions (inlet/exhaust) along the transverse engine axis. Findings not critical.
Smoothened area	Smoothened areas are on the running surface but almost the whole honing pattern is still visible. Smoothened areas appear brighter and more brilliant than the surrounding running surface. Findings not critical.
Bright area	Bright areas are on the running surface and show local removal of the honing pattern. Grooves from honing process are not visible any more.
Discoloration	This is caused by oxidation (surface discoloration through oil or fuel) and temperature differences around the liner. It appears rather darker within the honed structure in contrast to the bright metallic running surface. The honing pattern is undisturbed. Discolorations extend in stroke direction and may be interrupted. Findings not critical.
Corrosion fields / spots	Corrosion fields / spots result from water (condensed water) with the valves in the overlap (open) position. They are clearly visible due to the dark color of the honing groove bottom. This corrosion is not critical unless there is corrosion pitting.
Black lines	Black lines are a step towards heat discoloration. They are visible as a clear discoloration from TDC to BDC in the running surface and the start of localized damage to the honing pattern. Cylinder liners with a large number of black lines around the running surface have limited service life and should be replaced.

TIM-ID: 0000000014 - 013

Findings	Measure
Burn mark	This is caused by a malfunction in the liner / ring tribosystem. Usually they run over the whole ring-travel area (TDC/BDC), starting at the first TDC-ring and becoming more visible from the second TDC-ring 2 onwards and less pronounced from TDC-ring 1. The honing pattern is usually no longer visible and displays a clearly defined (straight) edge to the undisturbed surface. The damaged surface is usually discolored. The circumferential length varies. Liners with burn marks, or heat discoloration, starting in TDC ring 1 have to be replaced.
Seizure marks, scuffing	Irregular circumference lengths and depths. Can be caused either by the piston skirt or the piston crown. Material deposits on the liner (smear), heavy discoloration. Severe, visible scoring. Replace liner.

Evaluation of findings and further measures

The findings in the start phase of oxidation discoloration and heat discoloration are similar. A thorough investigation and compliance with the above evaluation criteria allow an unambiguous evaluation. To avoid unnecessary disassembly work, it is recommended that another inspection be carried out after further operation of the engine.

TIM-ID: 0000000014 - 013

7.4 Crankcase Breather

7.4.1 Crankcase breather – Cleaning oil pre-separator element

Preconditions

☑ Engine is stopped and starting disabled.

WARNING

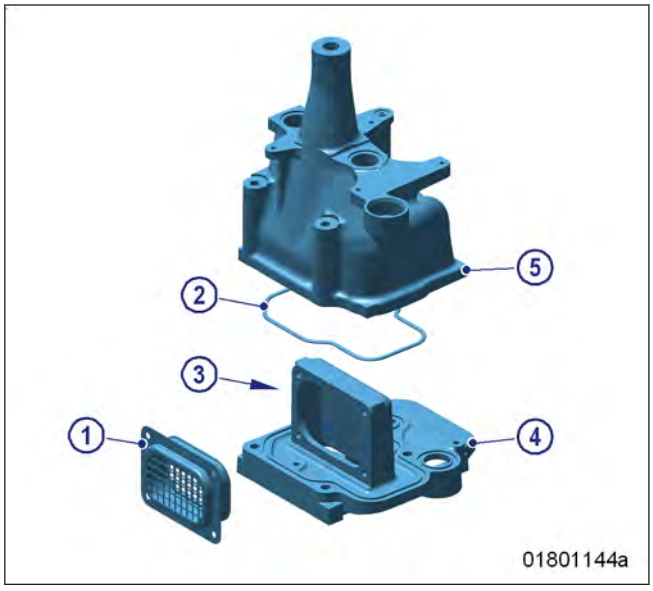
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

Compressed air
Risk of injury!
- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

Crankcase breather – Cleaning oil pre-separator element

1. Remove cover (5) from housing (4).
2. Take off oil pre-separator element (1), gasket (3) and O-ring (2).
3. Wash oil pre-separator element (1) and housing (4) in fuel and blow out with compressed air.
4. Moisten oil pre-separator element (1) with engine oil.
5. Position oil pre-separator element (1) with new gasket (3) and O-ring (2) on housing (4) and install cover (5).
6. Clean further oil pre-separator elements in the same way.



TIM-ID: 0000011545 - 004

7.4.2 Crankcase breather – Oil separator element replacement, diaphragm check and replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

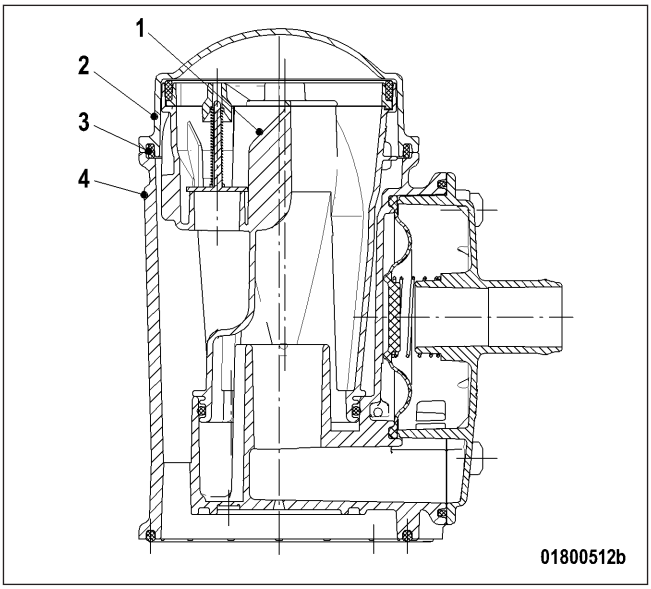
Designation / Use	Part No.	Qty.
Torque wrench, 6-50 Nm	F30027336	1
Ratchet	F30027340	1
Engine oil		
Filter element	(→ Spare Parts Catalog)	
Diaphragm	(→ Spare Parts Catalog)	
Gasket	(→ Spare Parts Catalog)	

WARNING

Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

Replacing oil separator element

1. Remove cover (2) with O-ring (3).
2. Remove filter element (1) from housing (4).
3. Insert new filter element in housing (4).
4. Install cover (2) with new O-ring.



5. Use torque wrench to tighten the screws of cover (2) to the specified torque.

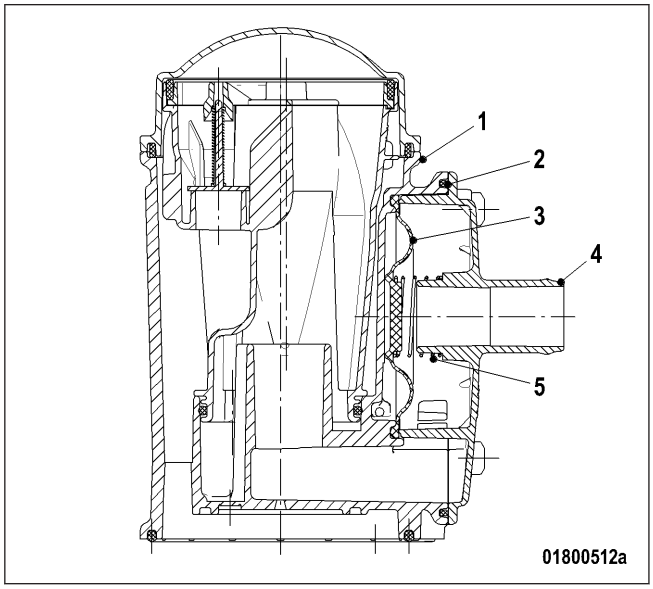
Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	10 Nm − 2 Nm

6. Replace further oil separator elements in the same way.

TIM-ID: 0000000017 - 007

Checking diaphragm

1. Remove cover (4).
2. Remove spring (5), gasket (2) and diaphragm (3).
3. Check diaphragm (3) for damage, fit new diaphragm if used one is damaged.
4. Install diaphragm (3) on housing (1).
5. Install new seal (2) and spring (5) together with cover (4).



6. Use torque wrench to tighten the screws of cover (4) to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	10 Nm − 2 Nm

7. Check diaphragms in further oil separators in the same way.

TIM-ID: 0000000017 - 007

7.5 Valve Drive

7.5.1 Valve clearance – Check and adjustment

Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine coolant temperature is max. 40 °C.

☑ Valves are closed.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y4345893	1
Barring tool	F6783914	1
Ratchet	F30006212	1
Double box wrench	F30002800	1
Angular screw driver	F30002816	1
Socket wrench	F30030450	1
Torque wrench, 10-60 Nm	F30510423	1
Measuring device	Y4345888	1

Preparatory steps

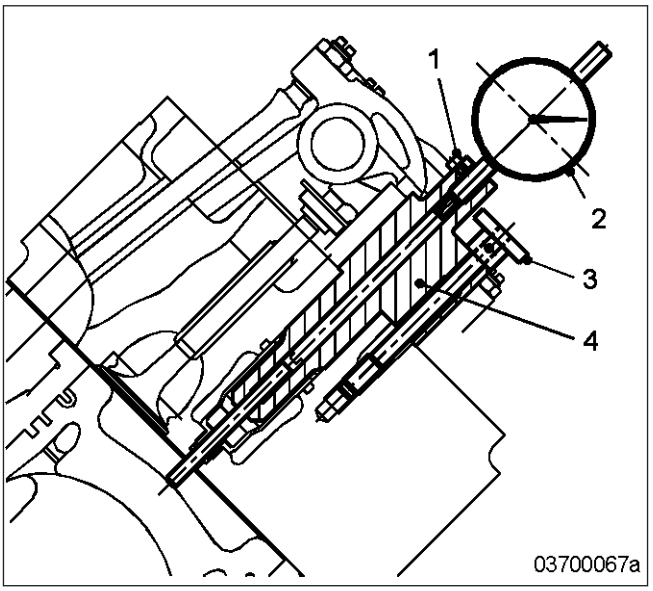
1. Remove air filter (→ Page 102).
2. Remove cylinder head cover (→ Page 87).

Positioning A1 piston at TDC

Note: With cylinder head and valve gear installed.

1. Install dial gauge (2) under preload in measuring device (4) and clamp with screw (1).
2. Install measuring device (4) in cylinder head and secure using knurled screw (3).
3. Zero dial gauge (2).
4. Turn engine using barring tool until piston A1 reaches firing TDC.

Result: The piston is at firing TDC when both rocker arms are unloaded, i.e. have clearance.



TIM-ID: 0000004363 - 004

Checking valve clearance at two crankshaft positions

1. Check TDC position of piston in cylinder A1:
   - If the rocker arms are unloaded on cylinder A1, the piston is in firing TDC.
   - If the rocker arms are loaded on cylinder A1, the piston is in overlap TDC.
2. Check valve clearance with cold engine:
   - Inlet (E) = 0.3 mm;
   - Exhaust (A) = 0.4 mm.
3. Check all valve clearances at two crankshaft positions (firing TDC and overlap TDC) according to the table below.

8V2000										
Position	Cylinder	1	2	3	4	5	6	7	8	9
Firing TDC in cylinder A1	Bank A	E A	- A	E -	- A					
	Bank B	E -	E -	- -	- A					
Overlap TDC in cylinder A1	Bank A	- -	E -	- A	E -					
	Bank B	- A	- A	E A	E -					
“E” = inlet valve clearance adjustment permitted, “A” = exhaust valve clearance adjustment permitted										
10V2000										
Position	Cylinder	1	2	3	4	5	6	7	8	9
Firing TDC in cylinder A1	Bank A	E A	- -	- -	- A	E -				
	Bank B	E -	- -	- A	E A	E -				
Overlap TDC in cylinder A1	Bank A	- -	E A	E A	E -	- A				
	Bank B	- A	E A	E -	- -	- A				
“E” = inlet valve clearance adjustment permitted, “A” = exhaust valve clearance adjustment permitted										
12V2000										
Position	Cylinder	1	2	3	4	5	6	7	8	9
Firing TDC in cylinder A1	Bank A	E A	E -	- A	E -	- A	- -			
	Bank B	E -	- -	- A	E -	E A	- A			
Overlap TDC in cylinder A1	Bank A	- -	- A	E -	- A	E -	E A			
	Bank B	- A	E A	E -	- A	- -	E -			
“E” = inlet valve clearance adjustment permitted, “A” = exhaust valve clearance adjustment permitted										
16V2000										
Position	Cylinder	1	2	3	4	5	6	7	8	9
Firing TDC in cylinder A1	Bank A	E A	- A	- A	E -	- A	E -	- -	- -	
	Bank B	E -	- A	- -	E -	E A	E -	E A	- A	
Overlap TDC in cylinder A1	Bank A	- -	E -	E -	- A	E -	- A	E A	E A	
	Bank B	- A	E -	E A	- A	- -	- A	- -	E -	
“E” = inlet valve clearance adjustment permitted, “A” = exhaust valve clearance adjustment permitted										
18V2000										
Position	Cylinder	1	2	3	4	5	6	7	8	9

TIM-ID: 0000004363 - 004

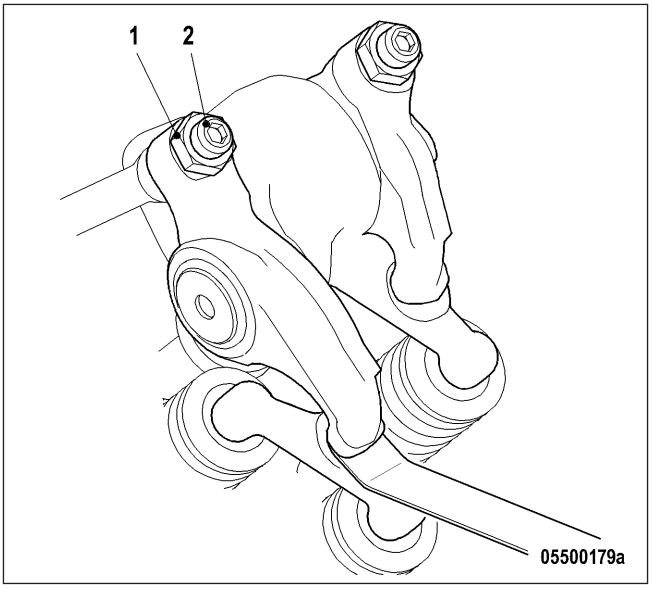
Firing TDC in cylinder A1	Bank A	E A	E -	- A	E -	- A	- -	- A	- -	- -
	Bank B	- A	- A	- -	E A	- -	E A	E -	E A	E -
Overlap TDC in cylinder A1	Bank A	- -	- A	E -	- A	E -	E A	E -	E A	E A
	Bank B	E -	E -	E A	- -	E A	- -	- A	- -	- A
“E” = inlet valve clearance adjustment permitted, “A” = exhaust valve clearance adjustment permitted										

4. Use feeler gauge to determine the distance between valve bridge and rocker arm.
5. If the deviation from the reference value exceeds 0.1 mm, adjust valve clearance.

Valve clearance adjustment

1. Loosen locknut (1) and unscrew adjusting screw (2) by a few threads.
2. Insert feeler gauge between valve bridge and rocker arm.
3. Readjust adjusting screw (2) so that the feeler gauge just passes through the gap.
4. Tighten locknut (1) with torque wrench to the prescribed tightening torque of 50 Nm while holding the adjusting screw (2) with Allen key.
5. Insert feeler gauge between valve bridge and rocker arm to verify that the gauge just passes through the gap.

Result: If not, adjust valve clearance.



Final steps

1. Remove barring tool.
2. Install cylinder head cover (→ Page 87).
3. Install air filter (→ Page 102).

TIM-ID: 0000004363 - 004

7.5.2 Cylinder-head cover – Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Centering device	F6783025	1
Gasket	(→ Spare Parts Catalog)	

Preparatory steps

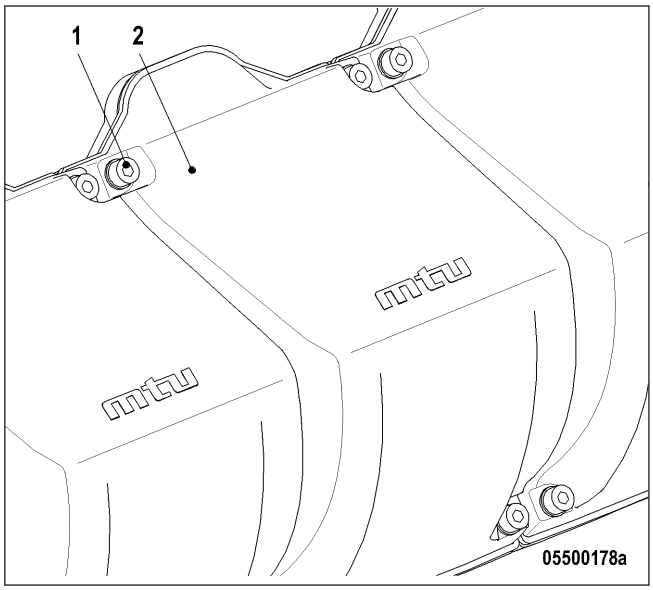
1. Remove air filter (→ Page 102).
2. Remove intake housing.

Cylinder-head cover – Removal and installation

1. Remove screws (1).
2. Remove cylinder-head cover (2) with gasket from cylinder head.
3. Clean mating faces.
4. Check condition of gasket of cylinder-head cover.

Result: Replace damaged gasket(s).

5. Center cylinder-head cover (2) with centering device.
6. Use torque wrench to tighten screws (1) to specified torque 20 Nm.



Final steps

1. Install air filter (→ Page 102).
2. Install intake housing.
3. Check cylinder-head covers for leaks.

TIM-ID: 0000004470 - 001

7.6 Injection Valve / Injector

7.6.1 Injector – Replacement

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Injector	(→ Spare Parts Catalog)	

Remove injector and install new one.

▶ (→ Page 89)

TIM-ID: 0000004642 - 002

7.6.2 Injector – Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Socket wrench	0005896803/00	1
Puller	F6790629	1
Double box wrench	F30011450	1
Open end wrench bit	F30025897	1
Box wrench adapter	F30451199	1
Alignment device	F6790507	1
Grease (Kluthe Hakuform 30-10/Emulgier)	X00029933	1
Engine oil		

WARNING

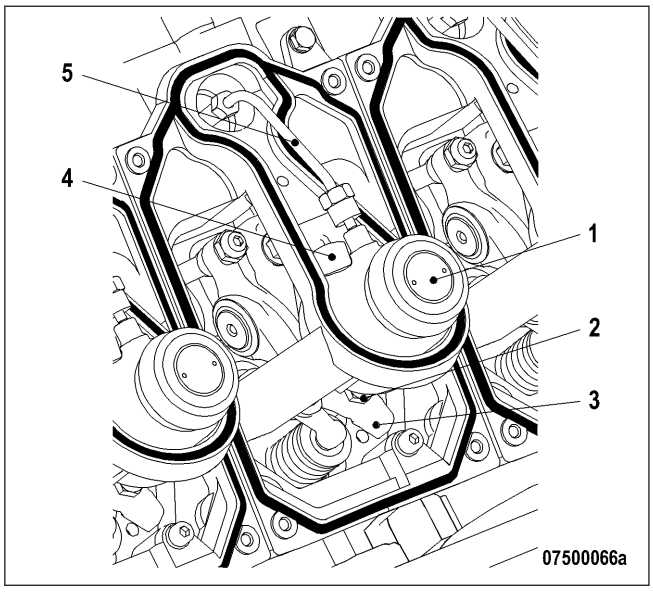
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Preparatory steps

1. Close fuel supply to engine.
2. Remove cylinder head cover (→ Page 87).

Removing injector

1. Remove HP line (5) using socket wrench.
2. Disconnect injector cable (4).
3. Remove screw (2).
4. Take off hold-down clamp (3).
5. Remove injector (1) with puller.
6. Remove O-rings from injector.
7. Mask all connections and bores or seal with suitable plugs.



TIM-ID: 0000004650 - 002

Installing injector

1. Remove all plugs before installation.
2. Fit new O-rings onto injector and coat with grease.
3. Fit new sealing ring with grease on injector, ensuring correct installation position of sealing ring.
4. Clean sealing surface on cylinder head and protective sleeve.
5. Insert injector (1) in cylinder head, ensuring that it is correctly aligned with the HP line connection.
6. Fit hold-down clamp (3) in correct installation position, coat screw (2) with engine oil.
7. Screw in screw (2) and tighten by hand.
8. Coat thread and sealing cone of HP line (5) and injector (1) with engine oil.
9. Align injector (1) and HP line (5) with alignment device.
10. Connect HP line (5) to HP accumulator and tighten by hand.
11. Connect HP line (5) to injector (1) and tighten by hand.
12. Tighten screw of hold-down clamp (3) with a box wrench adapter and a torque wrench to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M10 x 85	Tightening torque	(Engine oil)	40 Nm + 4 Nm

13. Use socket wrench and torque wrench to tighten HP line (5) to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
HP fuel line		Tightening torque	(Engine oil)	30 Nm + 5 Nm

14. Attach cable (4).

Final steps

1. Install cylinder head cover (→ Page 87).
2. Open fuel supply to engine.

TIM-ID: 0000004650 - 002

7.7 Fuel System

7.7.1 Fuel system – Venting

Preconditions

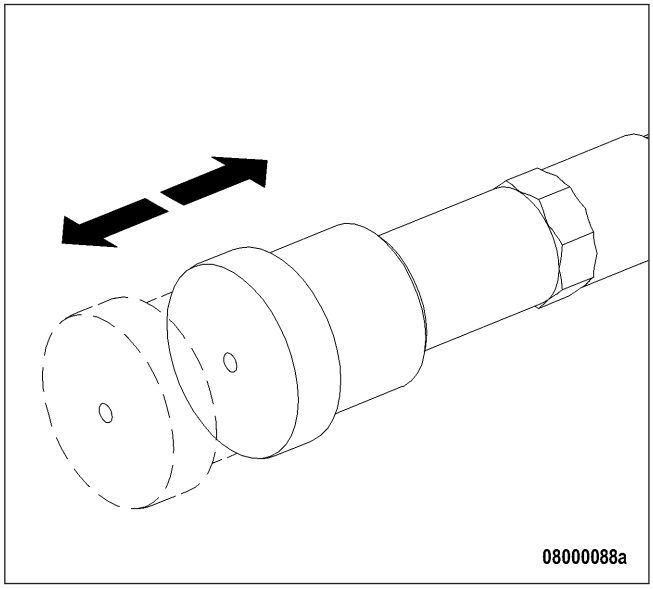
☑ Engine is stopped and starting disabled.

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Venting fuel system

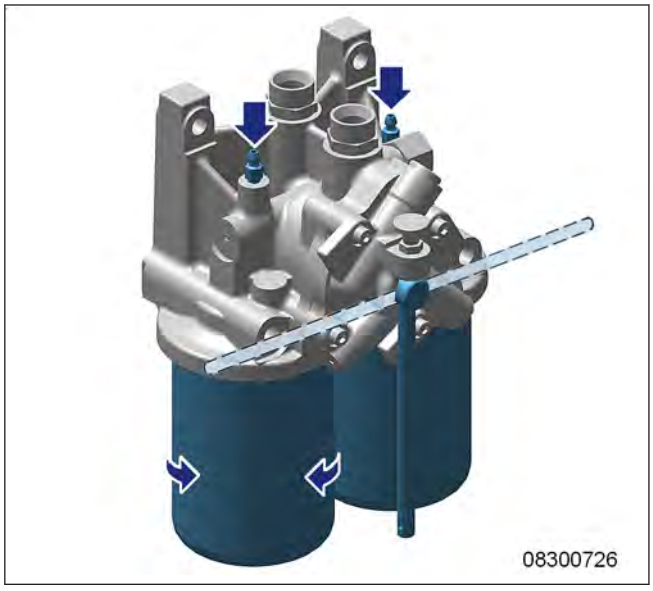
1. Unlock fuel priming pump, unscrew handle.



2. Open vent plugs on filter head.

Note: New version has two threaded vent plugs, old version has four threaded vent plugs.

3. Operate the pump with the handle until fuel without bubbles comes out of the vent plugs and the nipples.
4. Close vent plugs on filter head.
5. Operate the pump with the handle until fuel without bubbles comes out of the nipple.
6. Lock fuel priming pump, screw in handle.



TIM-ID: 0000004716 - 002

7.8 Fuel Filter

7.8.1 Fuel filter – Replacement

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Oil filter wrench	F30379104	1
Diesel fuel		
Easy-change filter	(→ Spare Parts Catalog)	

DANGER

Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

DANGER

Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.

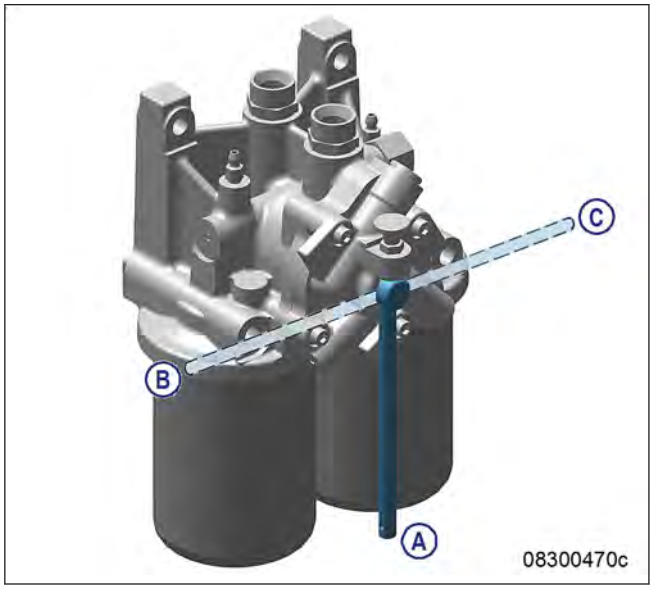
CAUTION

Damage to component.
Serious damage to plant!
- For filter replacement with the engine running, operate the engine at low engine load.
- The filter which is to be exchanged must be cut out for a brief period only.

TIM-ID: 0000004914 - 004

Easy-change fuel filter replacement with the engine stopped

1. Stop engine and disable engine start.
2. Cut out the filter to be replaced.
   - B Left filter cut out
   - C Right filter cut out
3. Remove cut-out easy-change filter using the oil filter wrench.
4. Clean sealing surface on filter head.
5. Check sealing ring of the new easy-change filter and coat it with fuel.
6. Fit SOLAS shield (→ Page 68).
7. Screw on easy-change filter and tighten by hand.
8. Set three-way cock to operating position (A) so that both filters are cut in (operating position).
9. Replace further fuel filters in the same way.
10. Vent fuel system (→ Page 91).

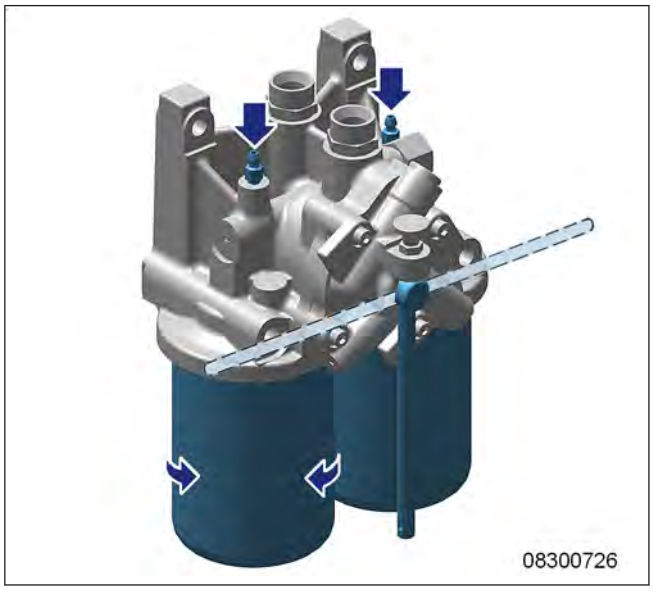


Easy-change fuel filter replacement with the engine running

1. Cut out the filter to be replaced.
2. Open the threaded vent plugs at the filter head of the cut-out filter and make sure that the fuel filter is not pressurized.

Note: New version has two threaded vent plugs, old version has four threaded vent plugs.

3. Close threaded vent plugs.
4. Remove cut-out easy-change filter using the oil filter wrench.
5. Clean sealing surface on filter head.
6. Check sealing ring of the new easy-change filter and coat it with fuel.
7. Fit SOLAS shield (→ Page 68).
8. Screw on easy-change filter and tighten by hand.
9. Set three-way cock to operating position (both filters cut in).
10. Replace further fuel filters in the same way.



TIM-ID: 0000004914 - 004

7.8.2 Fuel prefilter – Differential pressure check and adjustment of gauge

DANGER

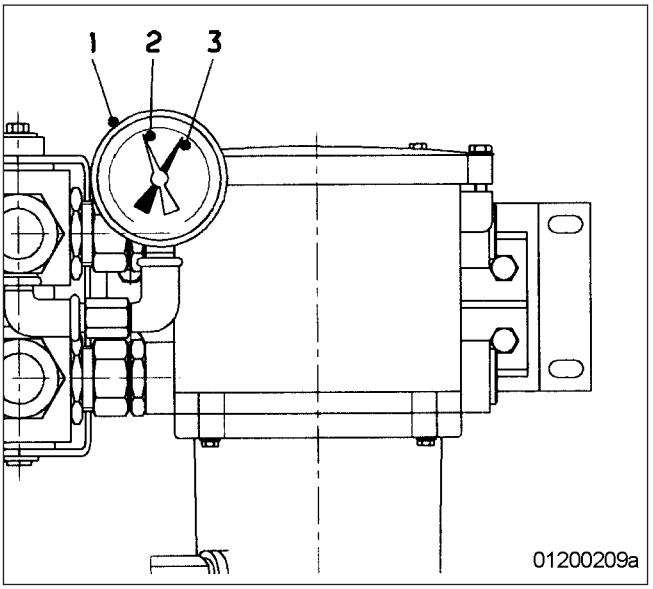
Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

WARNING

Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.

Differential pressure gauge adjustment

1. When installing the new filter element: align adjustable pointer (2) with pressure-indicating pointer (3) of pressure gauge (1).
2. Verify that differential pressure is within the limit.



Fuel prefilter – Checking differential pressure

1. With the engine running at full load or rated power, read off pressure at gauge (1).
2. If differential pressure as indicated between position of adjustable pointer (2) and pressure indicator of pressure gauge (3) is ≥ 0.3 bar, flush filter element of the cut-in filter (→ Page 96).

TIM-ID: 0000004926 - 003

7.8.3 Fuel prefilter – Draining

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

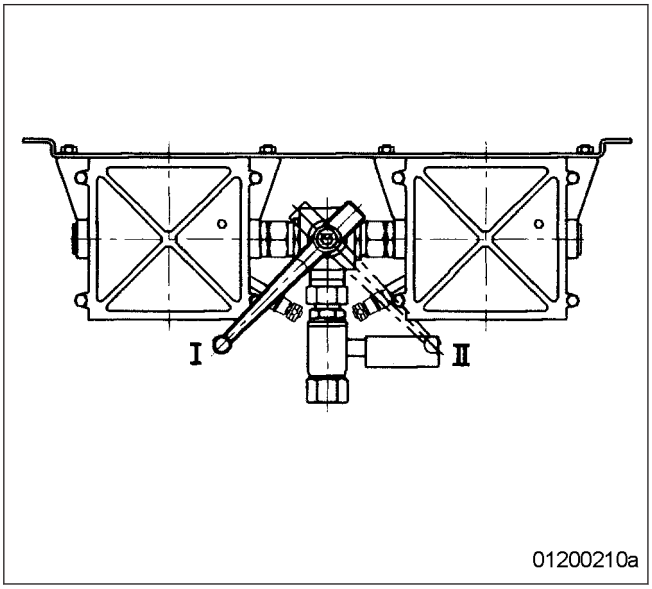
Designation / Use	Part No.	Qty.
Diesel fuel		
Seal	(→ Spare Parts Catalog)	

WARNING

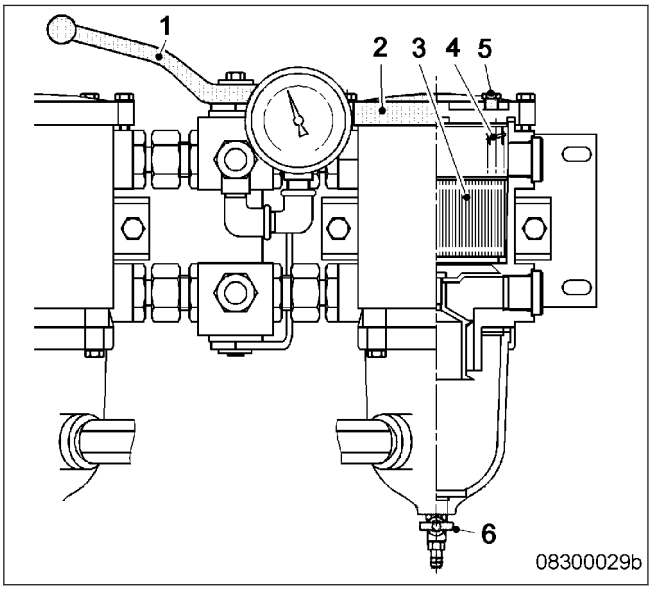
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Fuel prefilter – Draining

1. Cut out the filter to be drained.
   - I Left filter cut in
   - II Right filter cut in



2. Open threaded vent plug (5) of the filter to be drained.
3. Unlock drain valve (6) by pressing toggle and open it.
4. Drain water and contaminants from the filter until pure fuel emerges.
5. Close drain valve (6).
6. Remove screws securing the cover and take off cover (2).
7. Fill filter housing with clean fuel.
8. Place new seal in cover (2).
9. Fit cover with gasket and secure it with screws.
10. Cut in the cut-out filter again.
11. Close threaded vent plug (5) when fuel emerges from system.



TIM-ID: 0000004933 - 004

7.8.4 Fuel prefilter – Flushing

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Fuel		
Gasket	(→ Spare Parts Catalog)	

DANGER

Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

WARNING

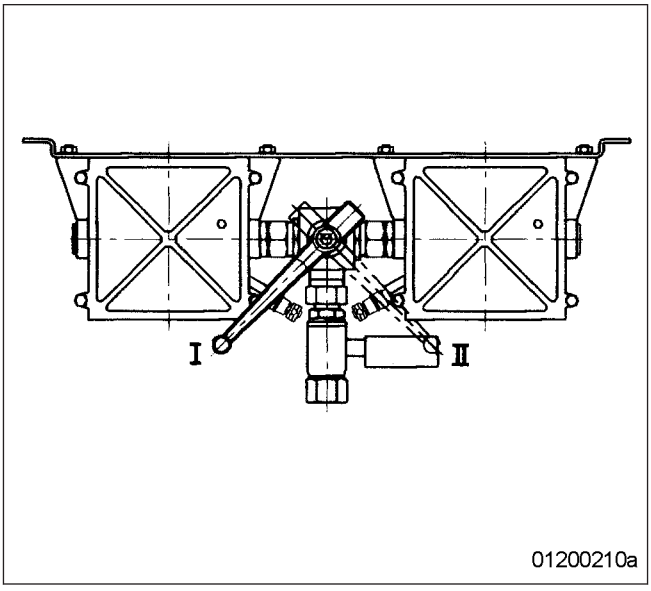
Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.

Fuel prefilter – Flushing

1. Cut out clogged filter.
   - I Left filter cut in
   - II Right filter cut in

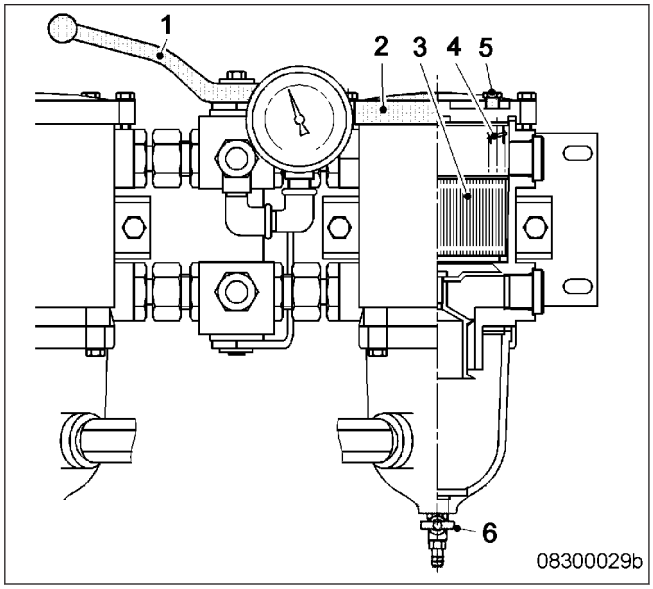


TIM-ID: 0000004937 - 015

2. Open threaded vent plug (5) of filter to be flushed.
3. Unlock drain valve (6) by pressing valve toggle, open it and drain fuel.

Result: Fuel flows from filtered side back to the unfiltered side, flushing the filter deposits downwards out of the filter.

4. Close threaded vent plug (5) and drain valve (6).



Fuel prefilter – Topping up with fuel

1. Stop engine (→ Page 58) and disable engine start.
2. Remove screws for cover and take off cover (2).
3. Fill filter housing with clean fuel.
4. Place new gasket in cover (2).
5. Fit cover with gasket and secure it with screws.
6. Check differential pressure (→ Page 94).

Result: If flushing did not lead to an improvement of the differential pressure, replace filter element of fuel prefilter (→ Page 98).

TIM-ID: 0000004937 - 015

7.8.5 Fuel prefilter – Filter element replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

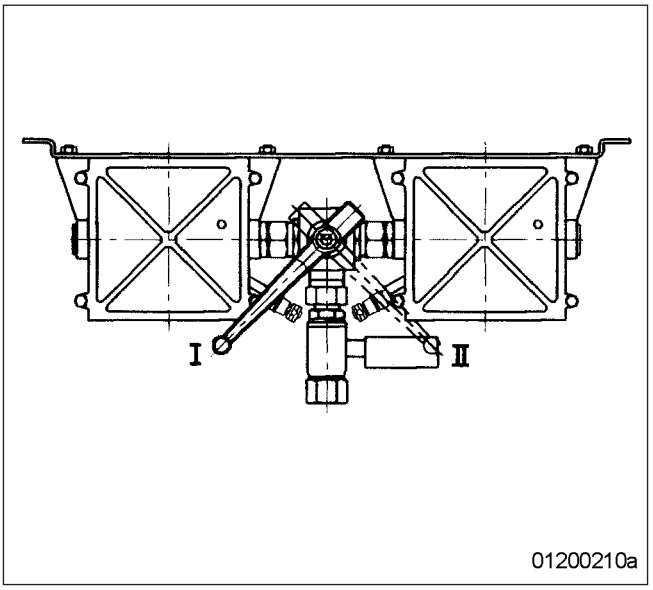
Designation / Use	Part No.	Qty.
Diesel fuel		
Filter element	(→ Spare Parts Catalog)	
Seal	(→ Spare Parts Catalog)	

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

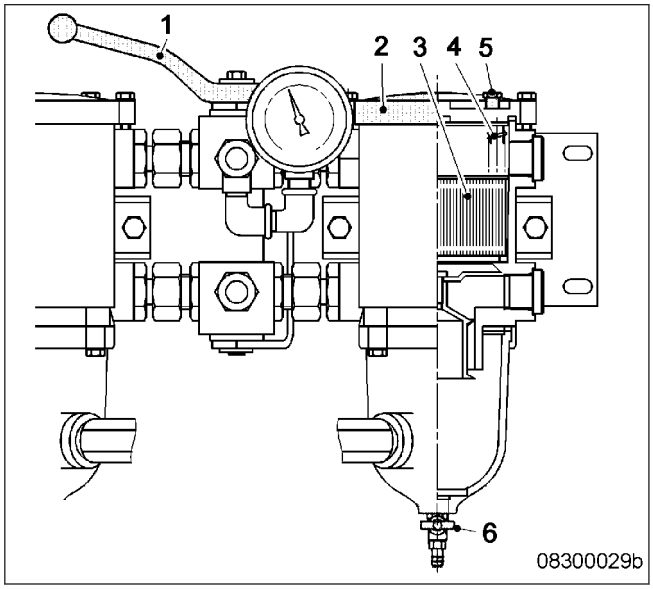
Replacing filter element

1. Cut out the contaminated filter.
   I Left filter cut in
   II Right filter cut in



TIM-ID: 0000004946 - 004

2. Open threaded vent plug (5) of contaminated filter.
3. Unlock drain valve (6) by pressing toggle and open it.
4. Drain water and contaminants from the filter.
5. Close drain valve (6).
6. Remove screws securing the cover and take off cover (2).
7. Remove spring housing (4) and filter element (3).
8. Insert new filter element (3) and spring housing (4).
9. Fill filter housing with clean fuel.
10. Place new seal in cover (2).
11. Fit cover with gasket and secure it with screws.
12. Cut in the cut-out filter again.
13. Close threaded vent plug (5) when fuel emerges.
14. Set adjustable pointer of differential pressure gauge (→ Page 94).



TIM-ID: 0000004946 - 004

7.9 Charge-Air Cooling

7.9.1 Intercooler – Checking condensate drain line for coolant discharge and obstruction

DANGER

Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

WARNING

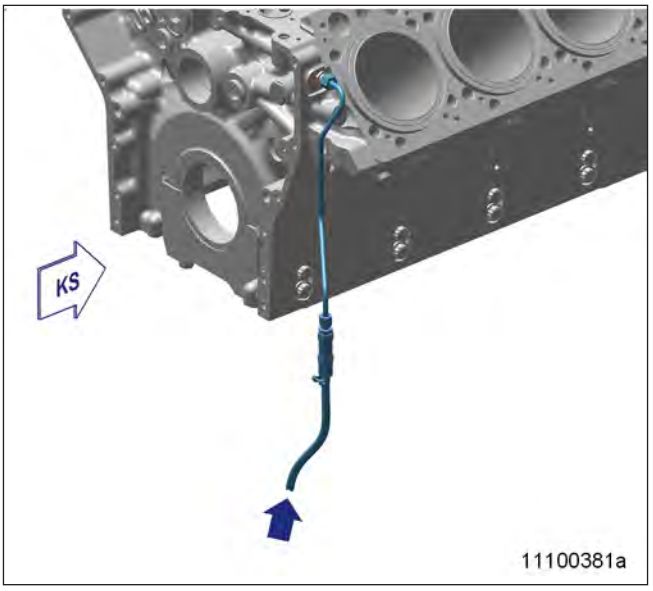
Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.

WARNING

Compressed air
Risk of injury!
- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

Intercooler – Checking condensate drain line for coolant discharge and obstruction

1. Check drain line for water discharge and obstruction when the engine is running idle.
2. If no air emerges, remove condensate drain line and blow out with compressed air.
3. Replace obstructed drain line by new one.
4. Install condensate drain line.
5. If a large amount of coolant is continuously discharged, the intercooler is leaking. Contact Service.



Emergency measures prior to engine start with a leaking intercooler

1. Remove injectors (→ Page 88).
2. Bar engine manually (→ Page 75).
3. Bar engine with starting system to blow out combustion chambers (→ Page 76).
4. Install injectors (→ Page 89).

TIM-ID: 0000027574 - 003

7.10 Air Filter

7.10.1 Air filter – Replacement

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Air filter	(→ Spare Parts Catalog)	

Replacing the air filter

1. Remove old air filter and install new air filter (→ Page 102).
2. Reset signal ring of contamination indicator (→ Page 103).

TIM-ID: 0000005447 - 009

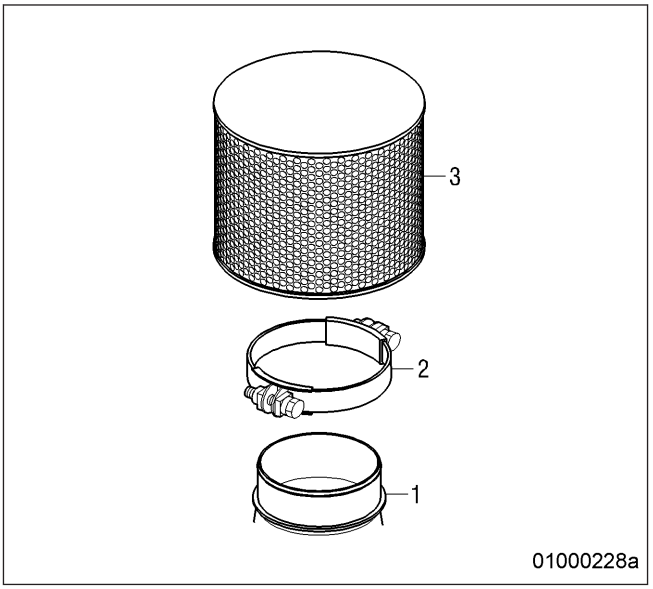
7.10.2 Air filter – Removal and installation

Preconditions

☑ Engine is stopped and starting disabled.

Removing and installing air filter

1. Release clamp (2).
2. Remove air filter (3) and clamp (2) from connecting flange of intake housing (1).
3. Verify that there are no objects in the connecting flange of the intake housing (1) and clean it.
4. Place new air filter (3) with clamp (2) onto intake housing (1).
5. Tighten clamp (2).



TIM-ID: 0000005457 - 006

7.11 Air Intake

7.11.1 Contamination indicator – Signal ring position check (optional)

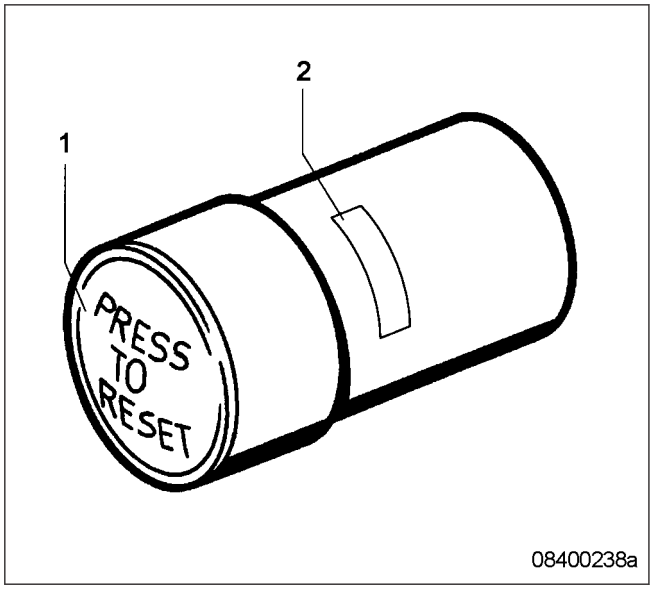
Preconditions

☑ Engine is stopped and starting disabled.

Checking signal ring position

1. If the signal ring is completely visible in the observation window (2), replace air filter (→ Page 101).
2. After installation of new filter, press reset button (1).

Result: Engaged piston with signal ring moves back to initial position.



TIM-ID: 0000005484 - 007

7.12 Starting Equipment

7.12.1 Starter – Condition check

Preconditions

☑ Engine is stopped and starting disabled.

Checking starter condition

1. Check securing screws of starter for secure seating and tighten if required.
2. Check wiring (→ Page 133).

TIM-ID: 0000000905 - 017

7.13 Lube Oil System, Lube Oil Circuit

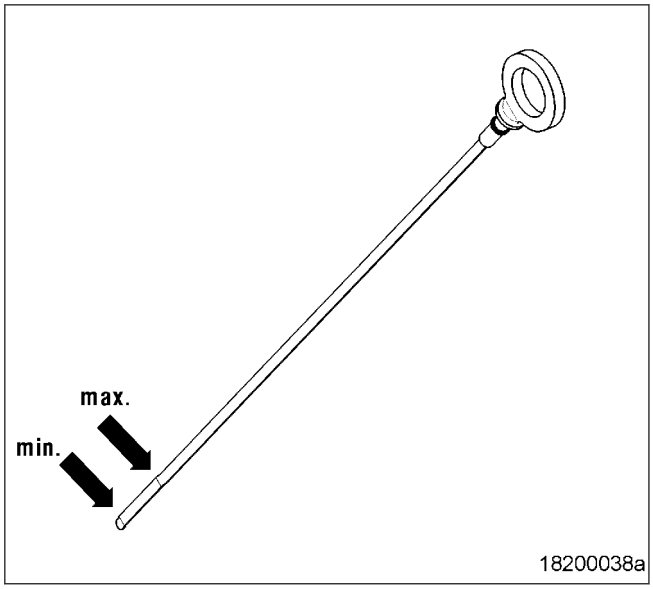
7.13.1 Engine oil – Level check

Preconditions

☑ Engine is stopped and starting disabled.

Oil level check prior to engine start

1. Withdraw oil dipstick from guide tube and wipe it.
2. Insert oil dipstick into guide tube up to the stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between "min." and "max." marks.
4. Top up to "max." if required (→ Page 106).
5. Insert oil dipstick into guide tube up to the stop.



Oil level check after the engine is stopped

1. 5 minutes after stopping the engine, remove oil dipstick from the guide tube and wipe it.
2. Insert oil dipstick into guide tube up to the stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between “min.” and "max." marks.
4. Top up to "max." if required (→ Page 106).
5. Insert oil dipstick into guide tube up to the stop.

TIM-ID: 0000000032 - 002

7.13.2 Engine oil – Change

Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine is at operating temperature.

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

WARNING

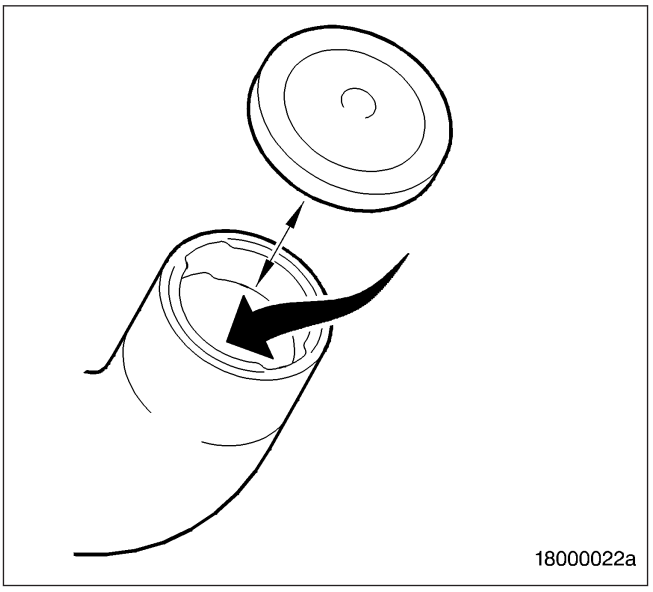
Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

Version with extraction equipment: Extracting engine oil

1. Position a suitable container to drain the engine oil into.
2. Extract all engine oil from oil pan using the extraction equipment.

Filling with new engine oil

1. Determine amount of engine oil required for oil change (→ Product Summary - Technical Data).
2. Open cover on filler neck.
3. Fill engine oil through filler neck up to “max.” mark on oil dipstick.
4. Close cover on filler neck.
5. Check engine oil level (→ Page 105).
6. After oil change, bar engine with starting system.



TIM-ID: 0000024903 - 001

7.14 Oil Filtration / Cooling

7.14.1 Engine oil filter – Replacement

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Oil filter wrench	F30379104	1
Engine oil		
Oil filter	(→ Spare Parts Catalog)	
Plastic ring	(→ Spare Parts Catalog)	

DANGER

Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

WARNING

Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.

WARNING

Hot oil.
Oil can contain combustion residues which are harmful to health.
Risk of injury and poisoning!
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

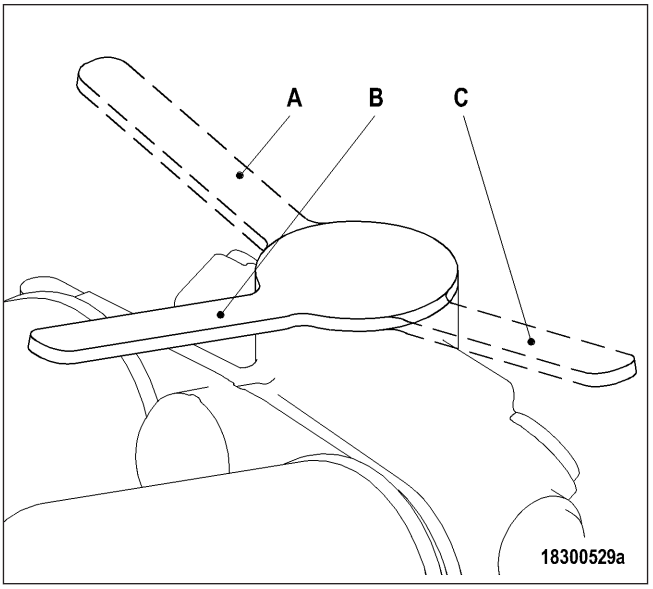
CAUTION

Damage to component.
Serious damage to plant!
- For filter replacement with the engine running, operate the engine at low engine load.
- The filter which is to be exchanged must be cut out for a brief period only.

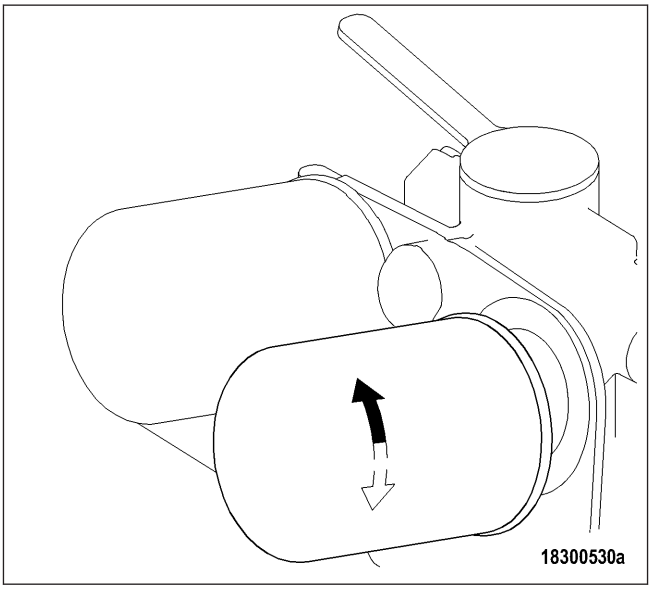
TIM-ID: 0000006385 - 005

Oil filter replacement with the engine stopped

1. Stop engine (→ Page 58) and disable engine start.
2. Cut out the filter to be replaced.
   - A Right filter cut out
   - B Both filters cut in (normal operating position)
   - C Left filter cut out



3. Remove cut-out oil filter using the oil filter wrench.
4. Clean sealing surface on connecting piece.
5. Check condition of new oil filter sealing ring and coat it with oil.
6. Fit SOLAS shield (→ Page 68).
7. Screw on and tighten new engine oil filter by hand.
8. Replace other oil filters in the same way.
9. Switch filter to normal position.
10. After each oil change and filter replacement, crank engine with starting system (→ Page 76).
11. Check oil level (→ Page 105).



Oil filter replacement with the engine running

1. Reduce engine speed to <1100 rpm.
2. Remove cut-out oil filter using the oil filter wrench.
3. Clean sealing surface on connecting piece.
4. Check condition of new oil filter sealing ring and coat it with oil.
5. Fit SOLAS shield (→ Page 68).
6. Screw on and tighten new engine oil filter by hand.
7. Replace other oil filters in the same way.
8. Switch filter to normal position.
9. Check oil level (→ Page 105).

TIM-ID: 0000006365 - 005

7.14.2 Centrifugal oil filter – Cleaning and filter-sleeve replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

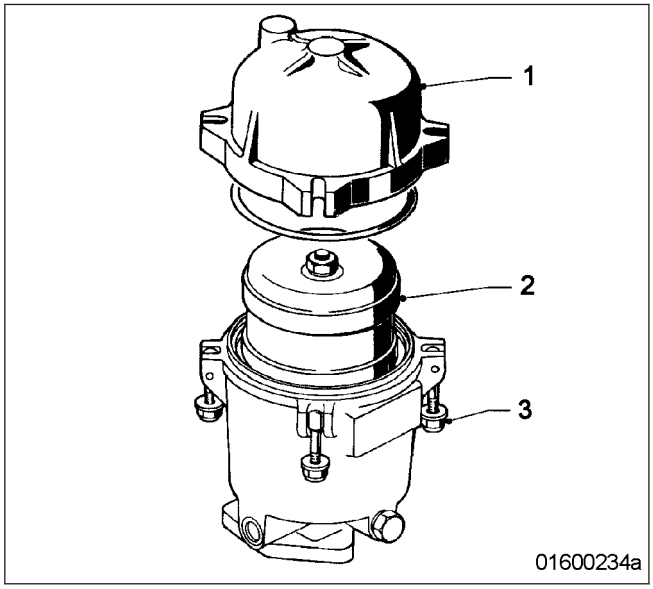
Designation / Use	Part No.	Qty.
Strap wrench	F30379104	1
Cold cleaner (Hakutex 50)	50622	1
Filter sleeve	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

WARNING

Compressed air
Risk of injury!
- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

Removing rotor of centrifugal oil filter

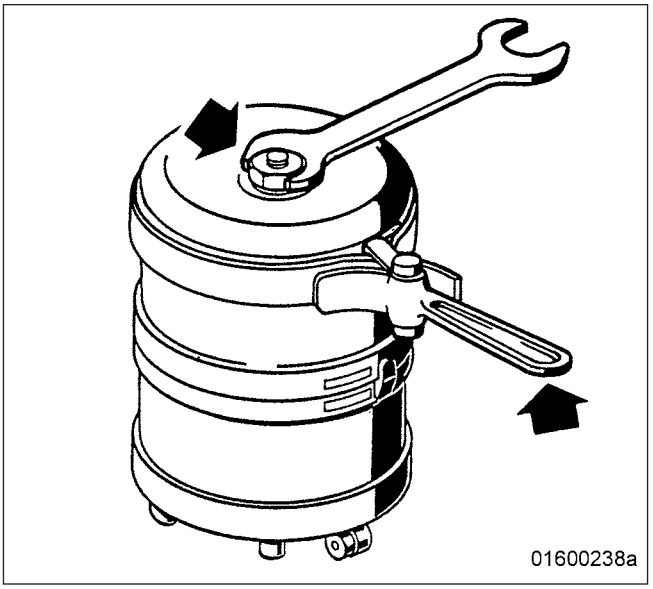
1. Release nuts (3).
2. Remove housing cover (1).
3. Remove complete rotor (2) from housing.



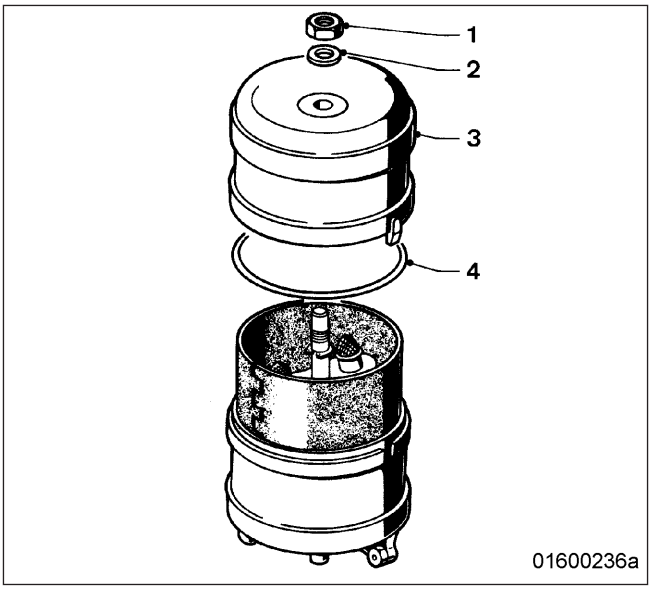
TIM-ID: 0000006418 - 002

Cleaning centrifugal oil filter and replacing filter sleeve

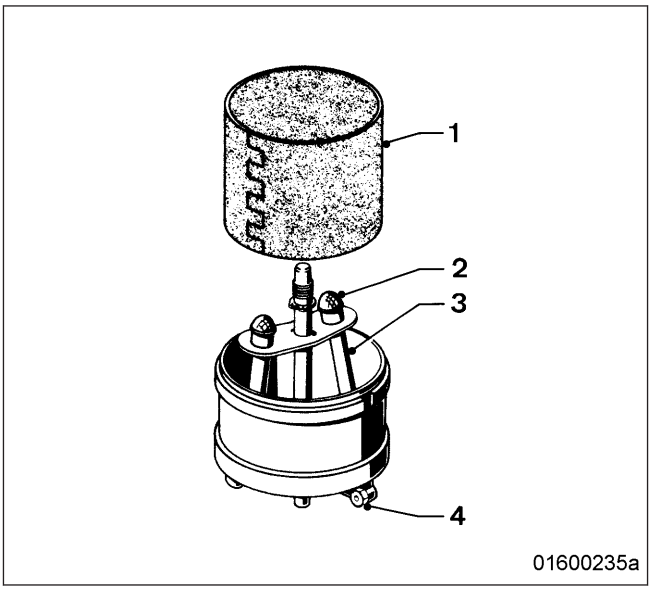
1. Remove nut, holding the rotor with a strap wrench.



2. Remove nut (1), washer (2), rotor cap (3) and sealing ring (4).

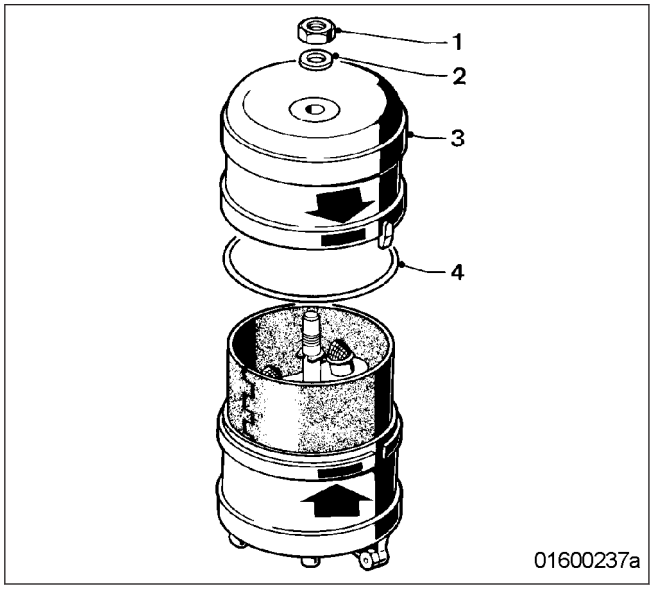


3. Remove sleeve (1).
4. Measure the layer thickness of the oil residue.
5. If maximum layer thickness (25 mm) is exceeded, shorten maintenance interval.
6. Clean rotor components and remove strainers (2).
7. Wash standpipes (3) and nozzles (4) with cleaner, blow out with compressed air.
8. Insert the new filter sleeve with the smooth surface facing the rotor cap.



TIM-ID: 0000006418 - 002

9. Fit new sealing ring (4).
10. Set on rotor cap (3), observe marks.
11. Fit washer (2).



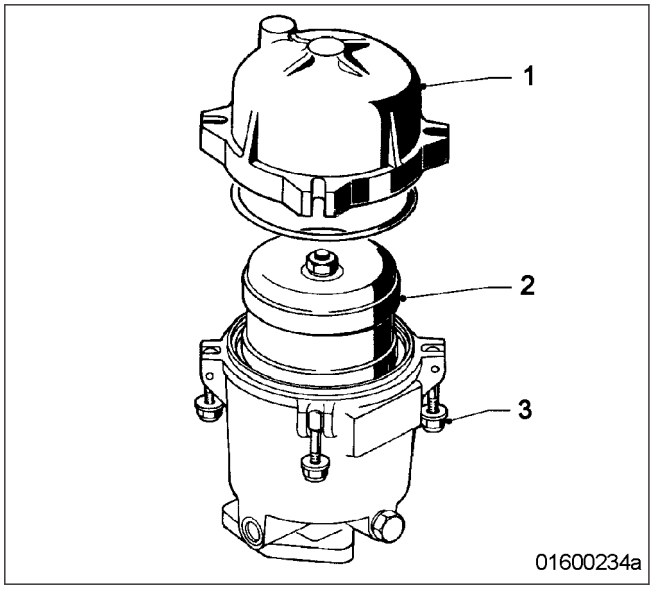
12. Hold rotor (new design) with strap wrench and tighten nut (1) with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Nut	M18 x 1.5	Tightening torque		10 Nm

13. Hold rotor (old design) with strap wrench and tighten nut (1) with torque wrench to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Nut	M16 x 1.5	Tightening torque		40 Nm to 50 Nm

14. Insert complete rotor (2) into the housing and check for ease-of-movement.
15. Set housing cover (1) with new sealing ring onto lower section, observe marks.
16. Tighten nuts (3) crosswise and evenly.

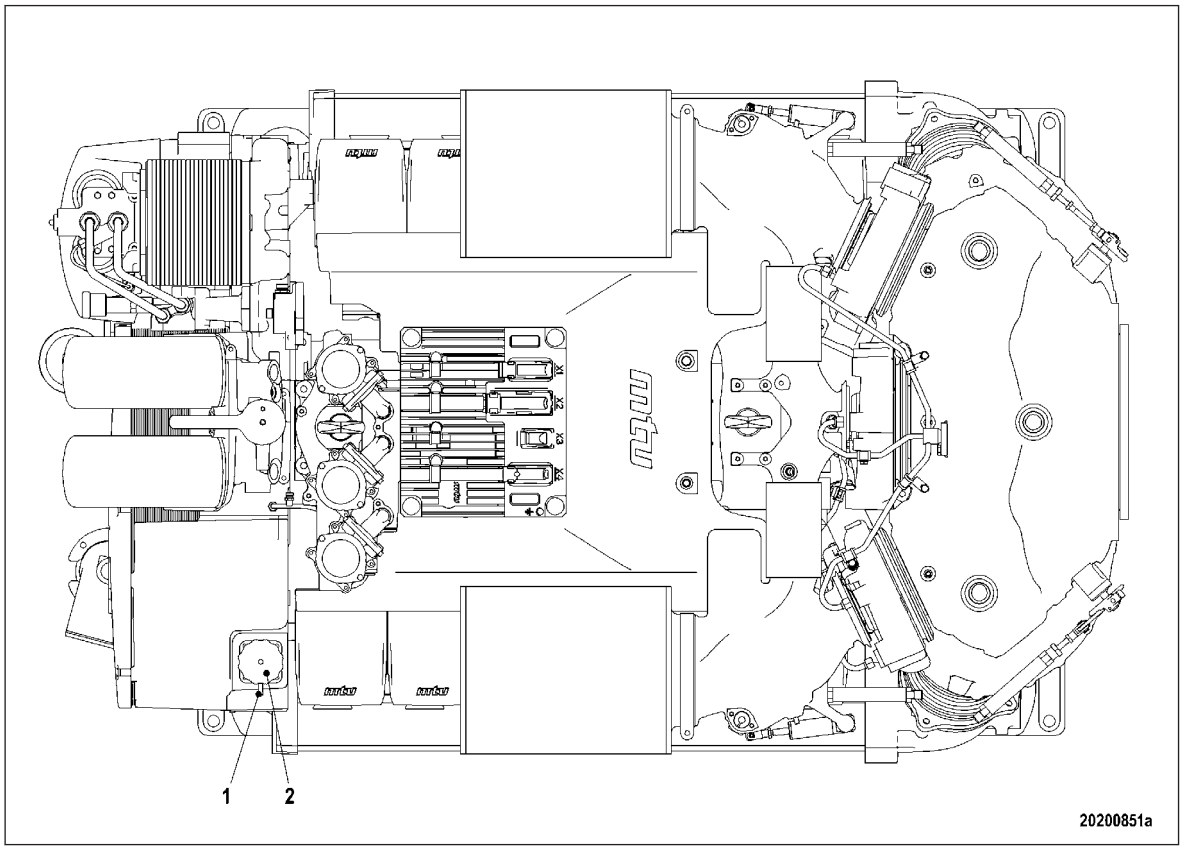


TIM-ID: 0000006418 - 002

7.15 Coolant Circuit, General, High-Temperature Circuit

7.15.1 Drain and venting points

12 V, 16 V

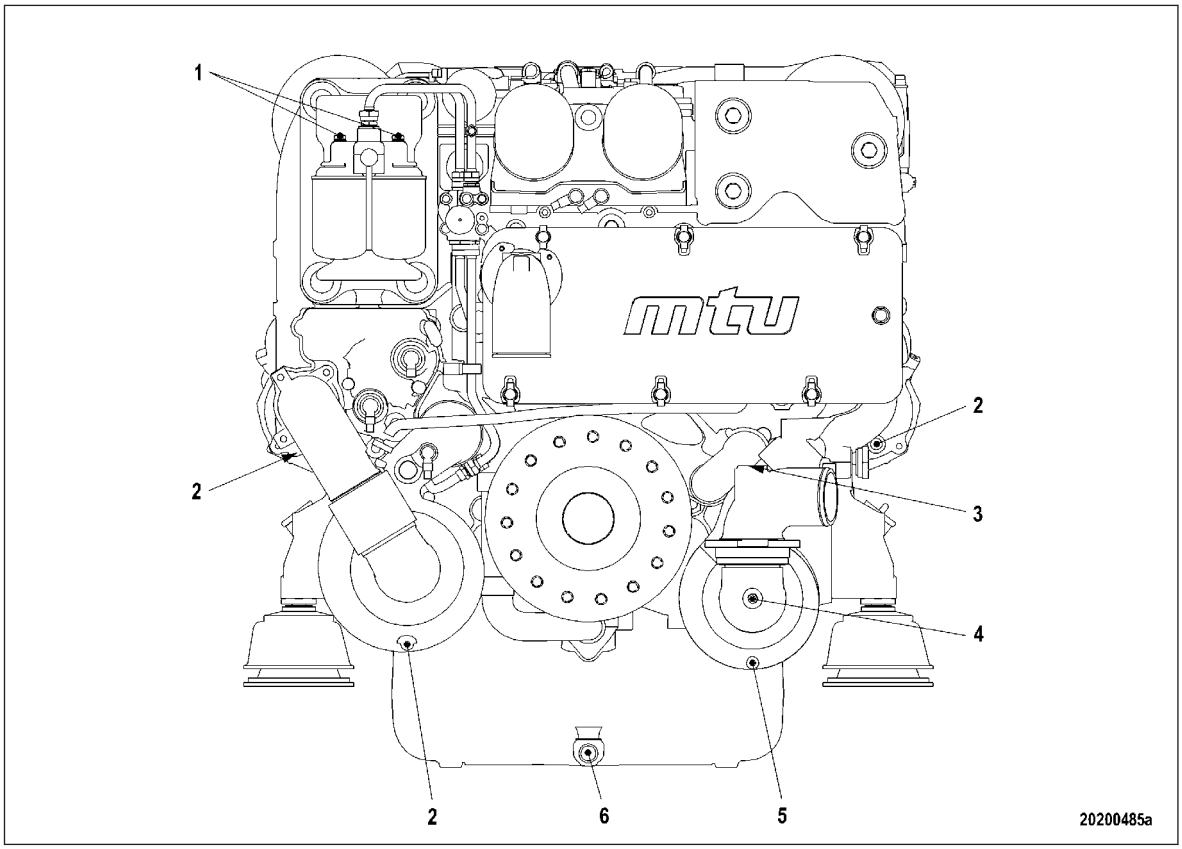


1 Overflow line, expansion tank

2 Filler neck

TIM-ID: 0000038198 - 001

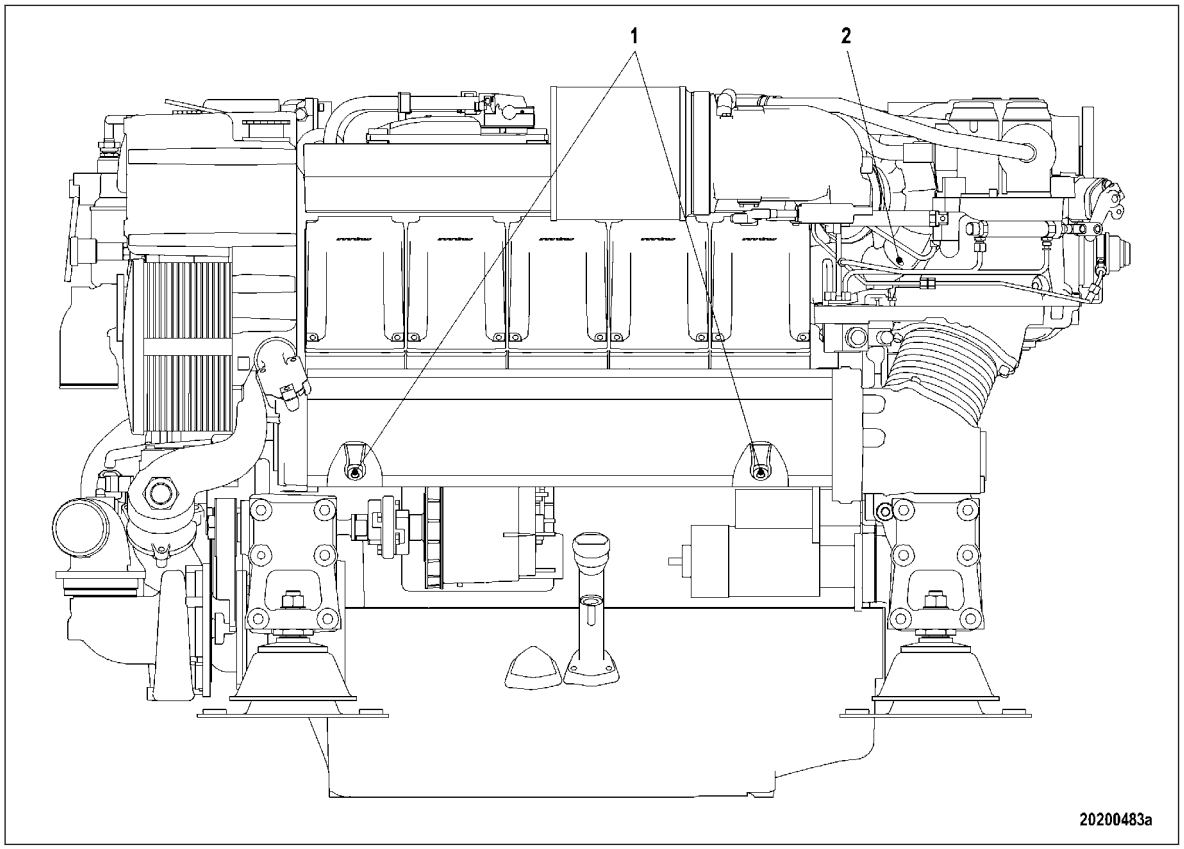
Free end (KGS)



1 Fuel filter vent screws
2 Engine coolant drain plug
3 Raw water pump filling plug
4 Measuring point, pressure before raw water pump
5 Raw water pump drain plug
6 Connection for oil extraction

TIM-ID: 0000038198 - 001

Left side

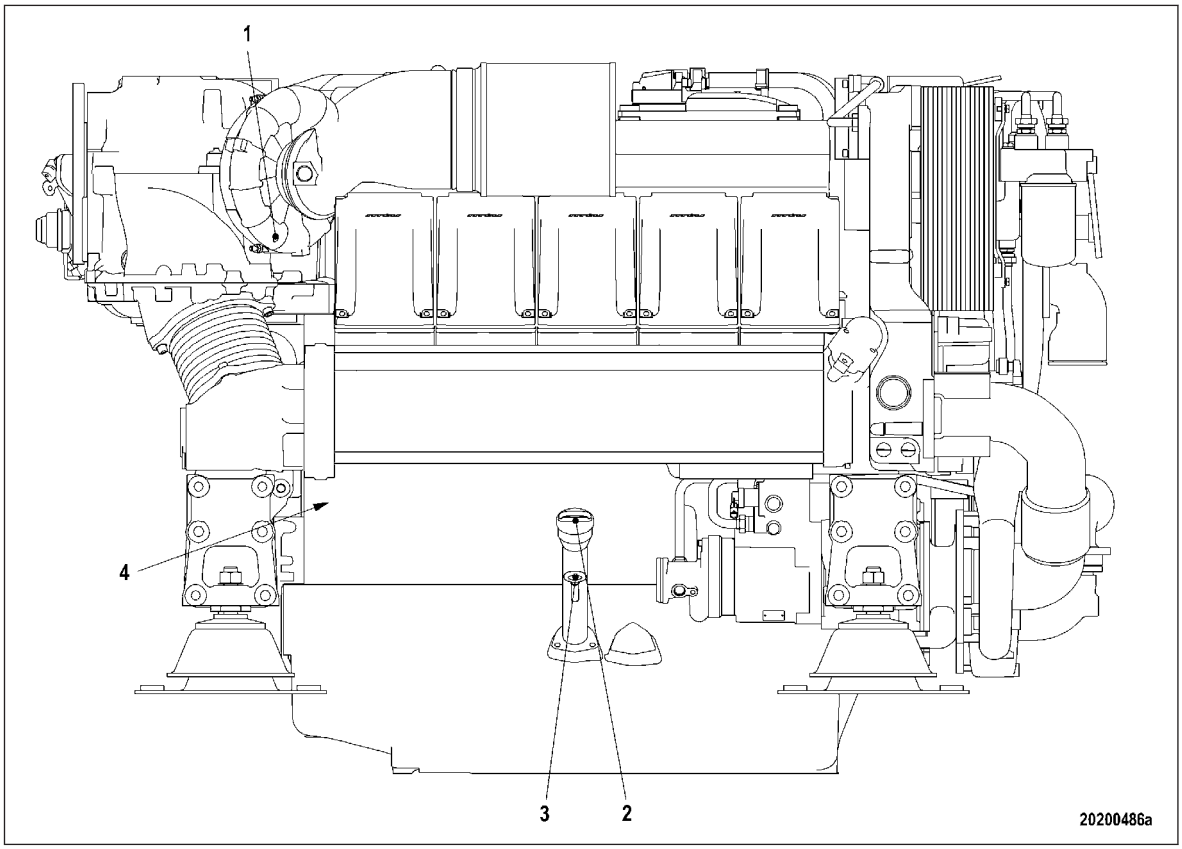


1 Engine coolant drain plug

2 Engine coolant drain plug (M14x1.5)

TIM-ID: 0000038198 - 001

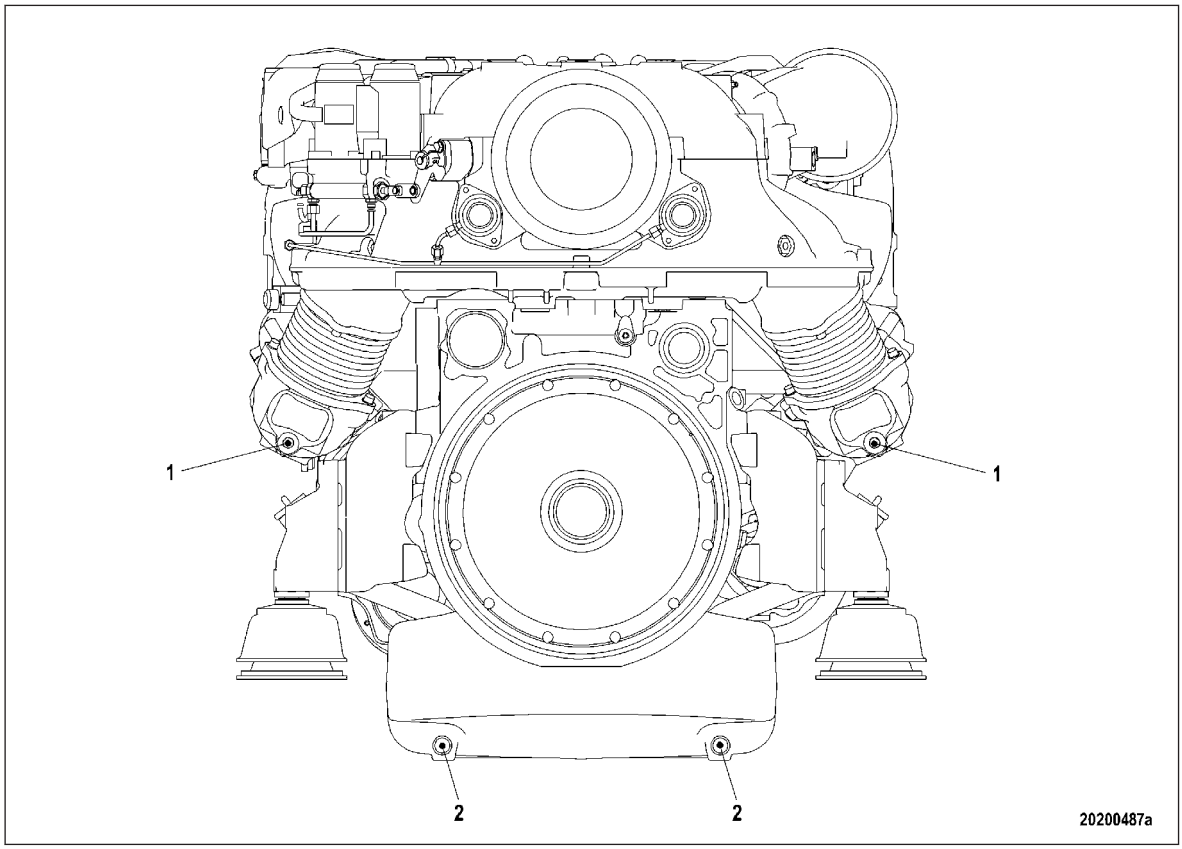
Right side



1 Engine coolant drain plug (M14x1.5)
2 Oil filler neck (connection on left or right engine selectable)
3 Oil dipstick (connection on left or right engine selectable)
4 Leak-fuel tank

TIM-ID: 0000038198 - 001

Driving end (KS)



1 Engine coolant drain plug

2 Connection for oil extraction

TIM-ID: 0000038198 - 001

7.15.2 Engine coolant – Level check

Preconditions

☑ Engine is stopped and starting disabled.

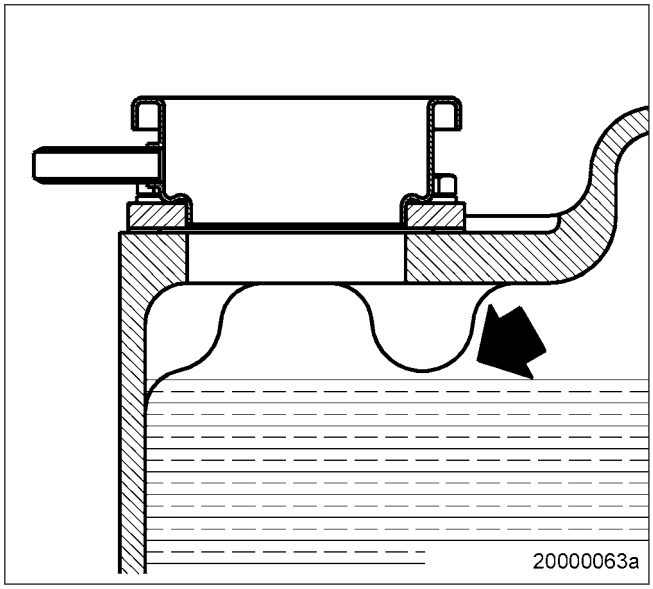
☑ MTU Fluids and Lubricants Specification (A001061/..) is available.

WARNING

Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Coolant-level check at filler neck:

1. Turn breather valve on coolant expansion tank (→ Page 34) counterclockwise until first stop and allow pressure to escape.
2. Continue to turn breather valve counter-clockwise and remove.
3. Check coolant level (coolant must be visible at the lower edge of the cast-in eye).



Coolant-level check by means of level sensor:

1. Switch engine control system on and check display (coolant level is automatically monitored by the engine control system).
2. If required, top up with treated engine coolant (→ Page 120).

TIM-ID: 0000006765 - 001

7.15.3 Engine coolant – Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Engine coolant – Change

1. Drain engine coolant (→ Page 119).
2. Fill with engine coolant (→ Page 120).

TIM-ID: 0000000036 - 030

7.15.4 Engine coolant – Draining

Preconditions

☑ Engine is stopped and starting disabled.

WARNING

Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Preparatory steps

1. Provide an appropriate container to collect the coolant or
2. switch on the extraction device.
3. Switch off preheating unit.

Engine coolant – Draining

1. Turn breather valve on coolant expansion tank (→ Page 112)counterclockwise to the first stop and release pressure.
2. Continue to turn breather valve counterclockwise and remove.
3. Draw off precipitated corrosion inhibitor oil from the expansion tank through filler neck.
4. Open drain valves or drain plugs (→ Page 112) and drain or pump off coolant.
5. Close all open drain points.
6. Set breather valve onto filler neck and close it.

TIM-ID: 0000006746 - 001

7.15.5 Engine coolant – Filling

Preconditions

☑ Engine is stopped and starting disabled.

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine coolant		

WARNING

Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

CAUTION

Cold coolant in hot engine can cause thermal stress.
Formation of cracks in components!
- Fill / top up coolant only into cold engine.

Filling engine coolant

1. (→ Page 34)Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Pour coolant into engine until coolant level reaches lower edge of cast-in eye of filler neck.
4. Check proper condition of breather valve and clean sealing faces.
5. Place breather valve on filler neck and close.
6. Start the engine and operate it at idle speed for some minutes.
7. Check coolant level (→ Page 117).

TIM-ID: 0000006728 - 002

7.15.6 HT coolant pump — Relief bore check

DANGER

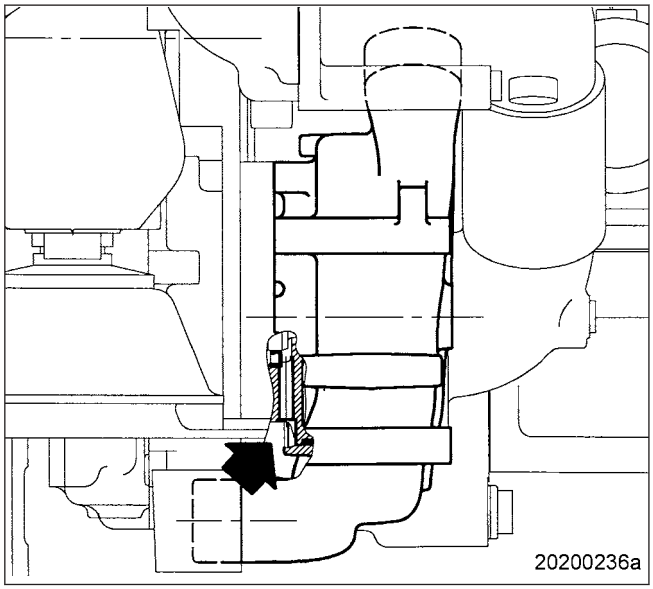
Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

WARNING

Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.

HT coolant pump — Relief bore check

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Operating instructions electronic system) and disable engine start.
3. Clean the relief bore with a wire if it is dirty.
   - Permissible engine coolant discharge: up to 10 drops per hour;
   - Permissible oil discharge: up to 5 drops per hour.
4. If discharge exceeds the specified limits, contact Service.



TIM-ID: 0000006803 - 002

7.15.7 Engine coolant – Sample extraction and analysis

Preconditions

☑ Engine is stopped and starting disabled.

☑ MTU Fluids and Lubricants Specification (A001061/..) is available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
MTU test kit	5605892099/00	1

WARNING

Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Engine coolant – Sample extraction and analysis

1. Turn breather valve on coolant expansion tank (→ Page 112)counterclockwise until first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Draw off precipitated corrosion inhibitor oil from expansion tank and dispose of oil.
4. Draw off approx. 1 liter coolant and drain into a clean container.
5. Using the equipment and chemicals from the MTU test kit, examine coolant for:
   - antifreeze concentration;
   - corrosion inhibitor concentration;
   - pH value.
6. Fit breather valve and close it.
7. Change engine coolant according to the coolant operating times specified in the (→ MTU Fluids and Lubricants Specifications A001061/..)(→ Page 119).

TIM-ID: 0000006774 - 001

7.15.8 Coolant filter – Replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

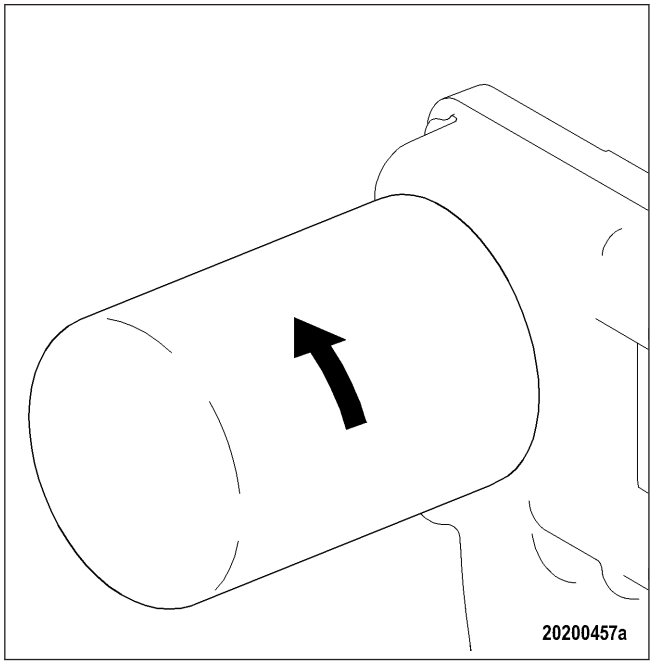
Designation / Use	Part No.	Qty.
Oil filter wrench	F30379104	1
Coolant filter	(→ Spare Parts Catalog)	

WARNING

Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Coolant filter – Replacement

1. Turn breather valve of coolant expansion tank counterclockwise (→ Page 34) to the first stop and allow pressure to escape.
2. Continue to turn breather valve counter-clockwise and remove.
3. Remove coolant filter using the oil filter wrench.
4. Clean the sealing face on the adapter.
5. Coat sealing ring of the new coolant filter with engine oil.
6. Install and tighten coolant filter by hand.
7. Close breather valve.
8. Check coolant level (→ Page 117).



TIM-ID: 0000006921 - 004

7.16 Raw Water Pump with Connections

7.16.1 Raw water pump – Relief bore check

DANGER

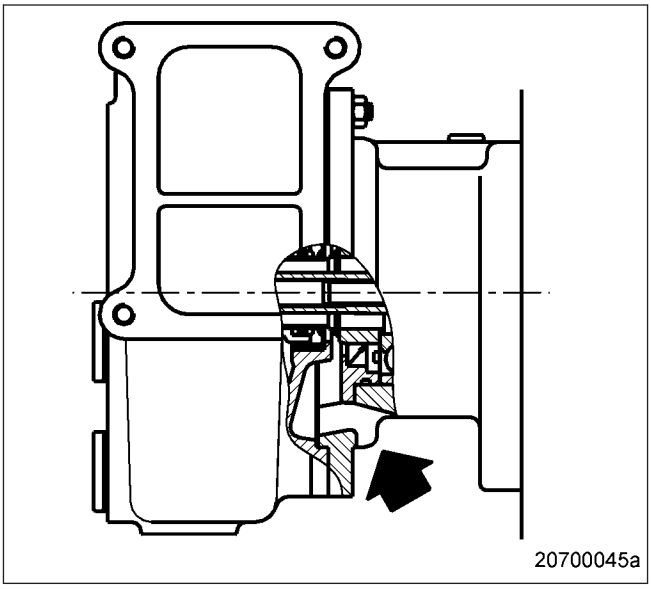
Unguarded rotating and moving engine components.
Risk of serious injury – danger to life!
- Take special care when working on a running engine.

WARNING

Engine noise above 85 dB (A).
Risk of damage to hearing!
- Wear ear protectors.

Raw water pump – Relief bore check

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Page 58) and disable engine start.
3. Clean the relief bore with a wire if it is dirty.
   - Permissible coolant discharge: up to 10 drops per hour;
   - Permissible oil discharge: up to 5 drops per hour.
4. If discharge exceeds the specified limits, contact Service.



TIM-ID: 0000007284 - 001

7.17 Belt Drive

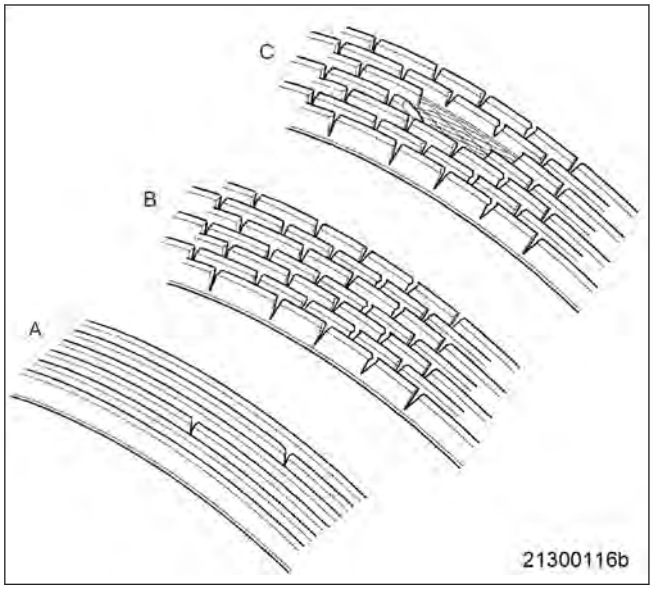
7.17.1 Drive belt – Condition check

Preconditions

☑ Engine is stopped and starting disabled.

☑ Guard is removed.

Drive belt – Condition check



Item	Findings	Action
Drive belt A	Singular cracks	None
Drive belt	Belt is oily, shows signs of over-heating	Replace (→ Page 126)
Drive belt B	Cracks on entire circumference	
Drive belt C	Chunking	

TIM-ID: 0000000920 - 010

7.18 Battery-Charging Generator

7.18.1 Battery-charging generator drive – Drive belt replacement

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Mandrel	8205892861/08	1

Preparatory steps

1. Remove safety equipment (if fitted).
2. Remove screws of protective cover (engine free end).
3. Remove protective cover.

Drive belt – Replacement

1. Hold adjusting lever at square.
2. Rotate adjusting lever until drive belt is released.
3. Use mandrel to lock adjusting lever in position.
4. Remove drive belt.
5. Check cleanness of belt pulleys.
6. Fit new drive belt.
7. Remove mandrel.

Final steps

1. Install protective cover.
2. Install screws of protective cover.
3. Install safety equipment (if fitted).
4. Check function of safety equipment (if fitted).

TIM-ID: 0000007424 - 003

7.19 Fuel Supply System

7.19.1 Water drain valve – Check

Water drain valve – Check

1. Open water drain valve.
2. Check water outlet for obstructions.
3. Close water drain valve.

TIM-ID: 0000007733 - 007

7.19.2 Differential pressure gauge – Check

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Checking differential pressure gauge

1. Switch on fuel treatment system (→ Page 56).
2. Set the alarm points at the differential pressure gauge to zero.

Result: Alarm is initiated with preset delay.

3. Reset the alarm points at the differential pressure gauge to the specified values.

TIM-ID: 0000007737 - 005

7.19.3 Water level probe (3-in-1 rod electrode) – Check

Preconditions

☑ System is put out of operation and emptied.

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Checking water level probe (3-in-1 rod electrode)

1. Disconnect connector from water level probe.
2. Unscrew water level probe.
3. Disconnect connector from water level probe.
4. Immerse water level probe into a tank filled with water until water level reaches the thread.
5. Switch system on.

Result: Water drain valve opens.

6. Leave water level probe in tank.

Result: Alarm must be triggered with the preset delay.

7. Switch off the system.
8. Disconnect connector from water level probe.
9. Remove water level probe from tank.
10. Screw in water level probe.
11. Connect connector for water level probe.
12. Fill and vent the system then put it into operation.

TIM-ID: 0000007739 - 007

7.19.4 Pump capacity – Check

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Pump capacity – Check

1. Install suitable pressure gauge in the intake connection of the pump.
2. Check pump pressure.
   a) Switch on fuel treatment system (→ Page 56).

Note: The pressure limiting valve at the pump might respond and open. Audible noise is caused by overflowing fuel and can be disregarded.

   b) Close ball valve at the outlet of the fuel treatment system.
   c) Check pressure at the pressure gauge in the inlet to the fuel treatment system and note down.
3. Checking pump pressure with reduced suction
   a) Reduce suction pressure of pump to -0.8 bar with the shut-off valve at the pump intake side.
   b) Check pressure at the pressure gauge in the inlet to the fuel treatment system and note down.
   c) Open ball valve at inlet and outlet of fuel treatment system.
4. Calculate wear limit.

Example:	
Measured value (normal condition).	3 bar
Measured value (reduced suction condition).	2.6 bar
If the measured value (reduced suction condition) is 10% lower than the measured value (normal condition), the wear limit is reached. Repair pump (contact Service).	

TIM-ID: 0000028612 - 001

7.19.5 Coalescer filter element – Replacement

Preconditions

☑ System is switched off and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 6-50 Nm	F30027336	1
Ratchet adapter	F30027339	1
Diesel fuel		
Engine oil		
Coalescer filter element	(→ Spare Parts Catalog)	
Gasket	(→ Spare Parts Catalog)	

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

CAUTION

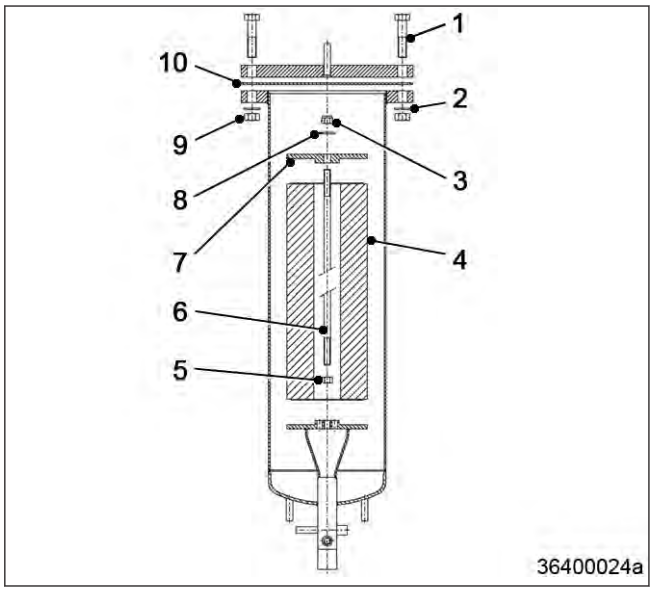
Contamination of components.
Damage to component!
- Observe manufacturer's instructions.
- Check components for special cleanness.

CAUTION

Incorrect installation of components and lines.
Damage to component!
- Ensure that components/lines are installed so that they are never under tension or strain.
- Ensure correct installation position of components.

Coalescer filter element – Replacement

1. Close ball valve at the inlet and outlet of the fuel treatment system.
2. Open drain valve.
3. Drain fuel.
4. Close drain valve.
5. Remove nut (9) with washer (2).
6. Remove screws (1).
7. Remove cover with gasket (10).
8. Remove nut (3), washer (8) and end plate (7).
9. Remove coalescer filter element (4).
10. Catch fuel as it runs out.
11. Clean housing with a non-linting cloth, rinse with fuel if required.
12. Check housing for corrosion.
13. Clean housing sealing surfaces.
14. Install coalescer filter element.
15. Install end plate (7), washer (8) and nut (3).



TIM-ID: 0000007735 - 007

16. Tighten nut (3) to specified tightening torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Nut	M16	Tightening torque	(Engine oil)	30 Nm +3 Nm

17. Fit gasket (10).
18. Install cover.
19. Install screw (1), washer (2) and nut (9).
20. Tighten nut (9).
21. Open ball valve at the inlet and outlet of the fuel treatment system.

Result: The fuel treatment system is ready for operation.

TIM-ID: 0000007735 - 007

7.20 Wiring (General) for Engine/Gearbox/Unit

7.20.1 Engine wiring – Check

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Isopropyl alcohol	X00058037	1

Engine wiring – Check

1. Check securing screws of cable clamps on engine and tighten loose threaded connections.
2. Ensure that cables are fixed in their clamps and cannot swing freely.
3. Check that cable ties are firm, tighten loose cable ties.
4. Replace faulty cable ties.
5. Visually inspect the following electrical line components for damage:
   - connector housings;
   - contacts;
   - sockets;
   - cables and terminals;
   - plug-in contacts.
6. (→ Contact Service) if cable conductors are damaged.

Note: Close male connectors that are not plugged in with the protective cap supplied.

7. Clean dirty connector housings, sockets and contacts with isopropyl alcohol.
8. Ensure that all sensor connectors are securely engaged.

TIM-ID: 0000000029 - 018

7.21 Accessories for (Electronic) Engine Governor / Control System

7.21.1 Engine governor and connectors – Cleaning

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Isopropyl alcohol	X00058037	1

Note: Always use test connectors to enter the connectors. Never use test leads for this purpose.Otherwise the contacts could be bent.

Engine governor and connectors – Cleaning

1. Remove coarse dirt from housing surface with isopropyl alcohol.
2. Remove dirt from connector and cable surfaces with isopropyl alcohol.
3. Check legibility of cable labels. Clean or replace illegible labels.

Cleaning severely contaminated connectors on the engine governor

Note: Seal unused connectors with the supplied protective cap.

1. Release the latch and pull off connectors.
2. Clean connector housings, connector socket housings and all contacts with isopropyl alcohol.
3. When connectors, sockets and all contacts are dry: Fit connectors and lock them.

TIM-ID: 0000000047 - 009

7.21.2 Engine governor – Checking plug-in connections

Preconditions

☑ Engine is stopped and starting disabled.

Note: Always use test connectors to enter the connectors. Never use test leads for this purpose.Otherwise the contacts could be bent.

Checking plug-in connections on engine governor

1. Check all plug-in connections for secure seating.
2. Latch connectors if loose.

TIM-ID: 0000000048 - 005

7.21.3 EMU – Checking plug-in connections

Preconditions

☑ Engine is stopped and starting disabled.

EMU – checking plug-in connections

1. Verify that all plug-in connections are securely seated.
2. Secure loose connectors and latch.

TIM-ID: 0000008395 - 001

7.21.4 Engine governor – Carry out self-test

DANGER

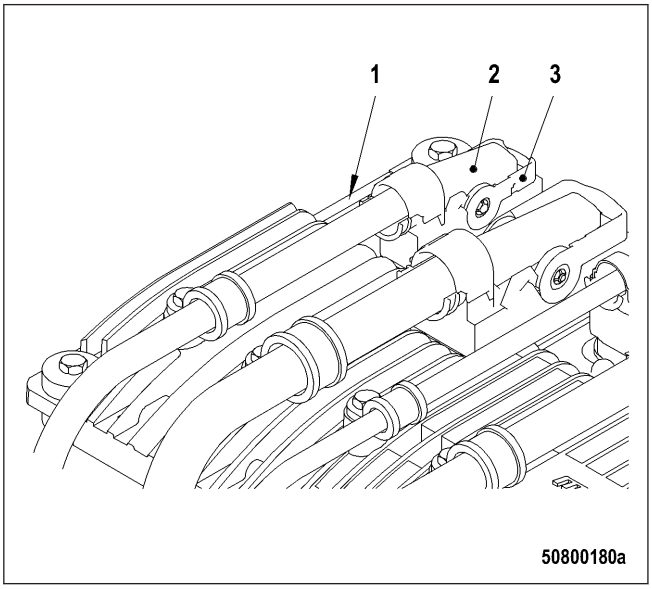
Electrical voltage.
Risk of serious injury - danger to life!
- Make certain that the power supply to the engine is switched off before starting to work. Ensure that the power supply cannot be switched on unintentionally!

Carrying out self-test

1. Switch off power supply to system.
2. Remove connectors X1, X2 and X4 from the engine governor.
   a) Release lock (3) of connectors (2).
   b) Unplug connector (2).
3. Switch on power supply

Result:
- The engine governor is operable if the diagnostic lamp (1) changes to continuous illumination within 30 seconds after power has been switched on.
- If the diagnostic lamp (1) flashes after 30 seconds, replace engine governor and (→ contact Service).
- Check the power supply if the diagnostic lamp remains dark.

4. Switch off power supply.
5. Refit connectors X1, X2 and X4 on engine governor.
   a) Plug in connector (2).
   b) Lock connectors.



TIM-ID: 0000008482 - 002

7.21.5 EMU and connectors – Cleaning

Preconditions

☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Isopropyl alcohol		

EMU and connectors – Cleaning

1. Remove coarse dirt from housing surface using a cloth moistened with isopropyl alcohol.
2. Remove dirt from connector and cable surfaces with isopropyl alcohol.
3. Check legibility of cable labels. Clean or replace illegible labels.

Cleaning severely contaminated EMU connectors

1. Release latches of connectors and withdraw connectors.
2. Clean connector housings, connector socket housings and all contacts with isopropyl alcohol.
3. When connectors, sockets and all contacts are dry: Fit connectors and secure latches.

TIM-ID: 0000008392 - 001

7.21.6 ECU 7 engine governor – Removal and installation

Preconditions

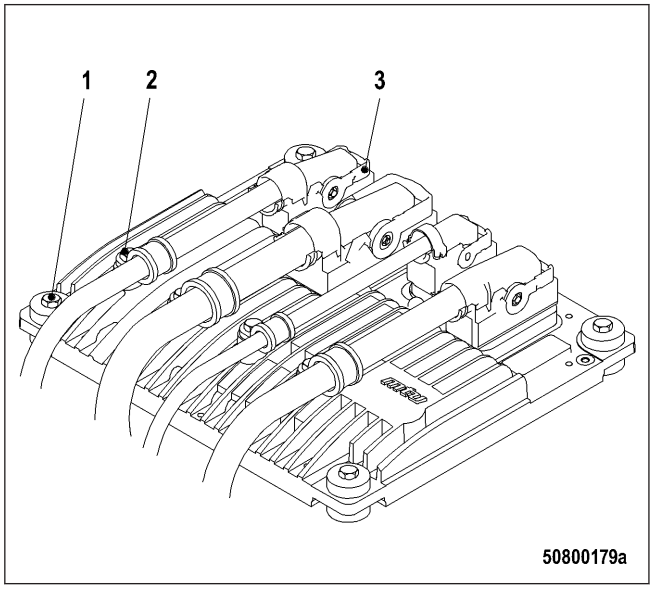
☑ Engine is stopped and starting disabled.

CAUTION

Wrong engine governor installed.
Engine damage!
- When reassembling an engine, make sure that the governor with the data record for the given engine is installed.

Removing engine governor from engine

1. Note or mark assignment of cables and connectors.
2. Remove all screws (2).
3. Undo latches (3) of the connectors.
4. Remove all connectors.
5. Remove screws (1).
6. Take off engine governor.



Installing engine governor on engine

1. Install in reverse order. In doing so, ensure correct assignment of connectors and sockets.
2. Check rubber mount before installation.

Result: If the rubber mount is porous or defective, replace it.

TIM-ID: 0000000049 - 005

7.21.7 Engine monitoring unit – Removal and installation

Preconditions

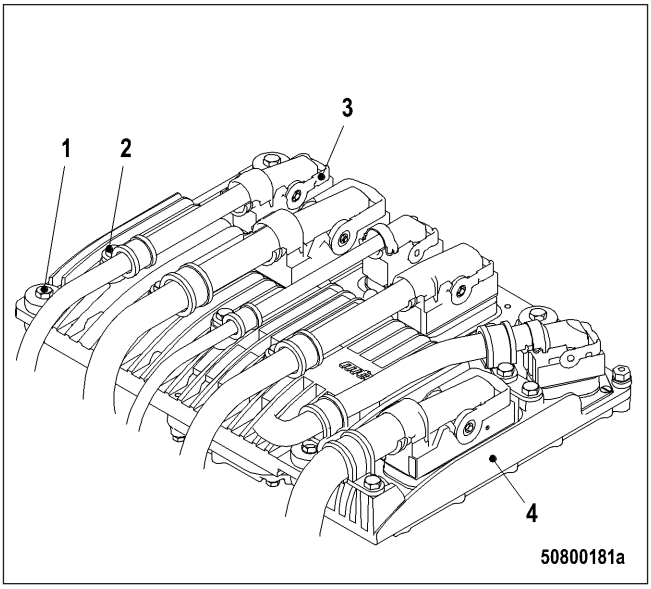
☑ Engine is stopped and starting disabled.

CAUTION

Wrong engine governor installed.
Engine damage!
- When reassembling an engine, make sure that the governor with the data record for the given engine is installed.

Removing engine governor with engine monitoring unit from engine

1. Note or mark assignment of cables and plugs.
2. Remove all screws (2).
3. Release lock (3) of connectors..
4. Remove all connectors.
5. Remove screws (1).
6. Remove engine governor (1) with engine monitoring unit (4).



Removing engine monitoring unit

1. Unscrew screws on base of EMU (4).
2. Remove EMU (4) with engine governor (1).

Installing engine monitoring unit

1. Place EMU (4) in position at engine governor (1).
2. Screw in and tighten screws on base of EMU (4).

Installing engine governor with engine monitoring unit on engine

1. Install in reverse order. Ensure correct assignment of plugs and sockets.
2. Check resilient mount before installing.

Result: If resilient mount is porous or defective then replace it.

TIM-ID: 0000008493 - 002

8 Appendix A

8.1 Abbreviations

Abbreviation	Meaning	Explanation
ADEC	Advanced Diesel Engine Control	Engine governor
AL	Alarm	Alarm (general)
ANSI	American National Standards Institute	Association of American standardization organizations
ATL	Abgasturbolader	Exhaust turbocharger (ETC)
BR	Baureihe	Series
BV	Betriebsstoffvorschrift	MTU Fluids and Lubricants Specifications, Publication No. A01061/..
CAN	Controller Area Network	Data bus system, bus standard
CCG	Cross Connection Gear	Transfer gearbox
CODAG	Combined Diesel (engine) And Gas (turbine propulsion)	
CPP	Controllable Pitch Propeller	
DAG	Diesel (engine) And Gas (turbine)	
DE	Diesel Engine	
DIN	Deutsches Institut für Normung e. V.	At the same time identifier of German standards (DIN = “Deutsche Industrie-Norm”)
DIS	Display unit	
DL	Default Lost	Alarm: CAN bus missing
ECS	Engine Control System	
ECS-UNI	Engine Control System UNIversal	
ECU	Engine Control Unit	Engine governor
EDM	Engine Data Module	
EMU	Engine Monitoring Unit	
ETK	Ersatzteilkatalog	Spare Parts Catalog (SPC)
FPP	Fixed Pitch Propeller	
GCU	Gear Control Unit	
GMU	Gear Monitoring Unit	
GT	Gas Turbine	
HAT	Harbor Acceptance Test	
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	Alarm: Measured value exceeds 2nd maximum limit value
HT	High Temperature	
ICFN	ISO – Continuous rating – Fuel stop power – Net	Power specification in accordance with DIN-ISO 3046-7

TIM-ID: 0000002049 - 005

Abbreviation	Meaning	Explanation
IDM	Interface Data Module	
IMO	International Maritime Organization	
ISO	International Organization for Standardization	International umbrella organization for all national standardization institutes
KGS	Kraftgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kraftseite	Engine driving end in accordance with DIN ISO 1204
LCD	Liquid Crystal Display, Liquid Crystal Device	
LCU	Local Control Unit	LOP subassembly
LED	Light Emitting Diode	
LMU	Local Monitoring Unit	LOP subassembly
LO	Low	Alarm: Measured value lower than 1st minimum limit value
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit value
LOP	Local Operating Panel	Control console, control panel
LOS	Local Operating Station	
MCS	Monitoring and Control System	
MG	Message	
MPU	Microprocessor Unit, Microprocessing Unit	
MRG	Main Reduction Gear	
OT	Oberer Totpunkt	Top Dead Center (TDC)
P-xyz	Pressure-xyz	Pressure measuring point xyz
PAN	Panel	Control panel
PCU	Propeller Control Unit	
PIM	Peripheral Interface Module	
PT	Power Turbine	
RCS	Remote Control System	
RL	Redundancy Lost	Alarm: Redundant CAN bus missing
SAE	Society of Automotive Engineers	U.S. standardization organization
SAT	Sea Acceptance Test	
SD	Sensor Defect	Alarm: Sensor failure
SDAF	Shut Down Air Flaps	Emergency-air shutoff flap(s)
SOLAS	International Convention for the Safety of Life at Sea	
SS	Safety System	Safety system alarm
SSK	Schnellschlussklappe(n)	Emergency air shut-off flaps
SSS	Synchronized Self-Shifting (clutch)	
STBD	Starboard	
T-xyz	Temperature-xyz	Temperature measuring point xyz

TIM-ID: 0000002049 - 005

Abbrevia-tion	Meaning	Explanation
TD	Transmitter Deviation	Alarm: Deviation in transmitter values
UT	Unterer Totpunkt	Bottom Dead Center (BDC)
VS	Voith Schneider	Voith Schneider drive
WJ	Water jet	Water jet drive
WZK	Werkzeugkatalog	Tool Catalog (TC)
ZKP	Zugehörigkeit-Kategorie-Parameter	Assignment category parameter; number scheme for signals from the ADEC engine governor

TIM-ID: 0000002049 - 005

8.2 MTU contact persons/service partners

Our worldwide sales network with its subsidiaries, sales offices, representatives and customer service centers ensures fast and direct support on site and the high availability of our products.

Local support

Experienced and qualified specialists place their knowledge and expertise at your disposal.

For locally available support, go to the MTU Internet site: http://www.mtu-online.com

24h hotline

With our 24h hotline and the outstanding flexibility of our service staff, we are always ready to assist you – either during operation, for preventive maintenance, corrective work in case of malfunction or changed operating conditions, or for spare parts supply.

Your contact at Headquarters: Service-support@mtu-online.com

Spare parts service

Fast, simple and correct identification of spare parts for your drive system or vehicle fleet. The right spare part at the right time at the right place.

With this aim in mind, we can call on a globally networked spares logistics system, a central warehouse at headquarters and on-site stores at our subsidiary companies, agencies and service workshops.

Your contact at Headquarters:

E-mail: spare.parts@mtu-online.com

Phone: +49 7541 908555

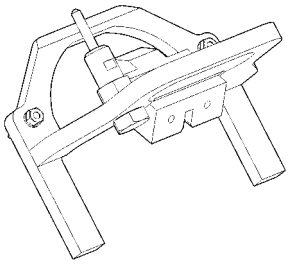
Fax: +49 7541 908121

TIM-ID: 0000000873 - 014

9 Appendix B

9.1 Special Tools

Alignment device

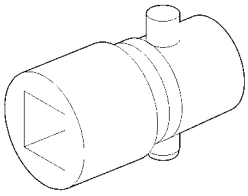


Part No.:	F6790507
Qty.:	1
Used in:	7.6.2 Injector – Removal and installation (→ Page 89)

Angular screw driver

Part No.:	F30002816
Qty.:	1
Used in:	7.5.1 Valve clearance – Check and adjustment (→ Page 84)

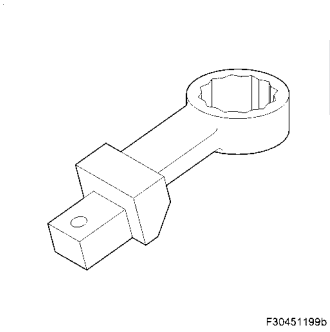
Barring tool



Part No.:	F6783914
Qty.:	1
Used in:	7.2.1 Engine – Barring manually (→ Page 75)
Qty.:	1
Used in:	7.5.1 Valve clearance – Check and adjustment (→ Page 84)

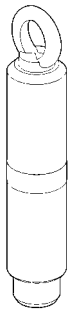
DCL-ID: 0000010704 - 004

Box wrench adapter



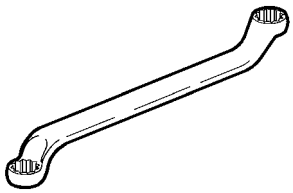
Part No.:	F30451199
Qty.:	1
Used in:	7.6.2 Injector – Removal and installation (→ Page 89)

Centering device



Part No.:	F6783025
Qty.:	1
Used in:	7.5.2 Cylinder-head cover – Removal and installation (→ Page 87)

Double box wrench



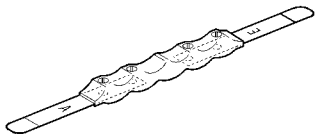
Part No.:	F30002800
Qty.:	1
Used in:	7.5.1 Valve clearance – Check and adjustment (→ Page 84)

Double box wrench

Part No.:	F30011450
Qty.:	1
Used in:	7.6.2 Injector – Removal and installation (→ Page 89)

DCL-ID: 000001070 4 - 004

Feeler gauge



Y4_345893

Part No.:	Y4345893
Qty.:	1
Used in:	7.5.1 Valve clearance – Check and adjustment (→ Page 84)

Mandrel

Part No.:	8205892861/08
Qty.:	1
Used in:	7.18.1 Battery-charging generator drive – Drive belt replacement (→ Page 126)

Measuring device

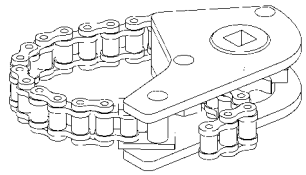
Part No.:	Y4345888
Qty.:	1
Used in:	7.5.1 Valve clearance – Check and adjustment (→ Page 84)

MTU test kit

Part No.:	5605892099/00
Qty.:	1
Used in:	7.15.7 Engine coolant – Sample extraction and analysis (→ Page 122)

DCL-ID: 0000010704 - 004

Oil filter wrench

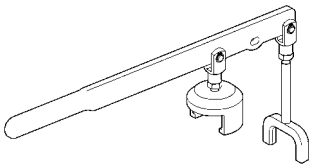


Part No.:	F30379104
Qty.: Used in:	1 7.8.1 Fuel filter – Replacement (→ Page 92)
Qty.: Used in:	1 7.14.1 Engine oil filter – Replacement (→ Page 107)
Qty.: Used in:	1 7.15.8 Coolant filter – Replacement (→ Page 123)

Open end wrench bit

Part No.:	F30025897
Qty.: Used in:	1 7.6.2 Injector – Removal and installation (→ Page 89)

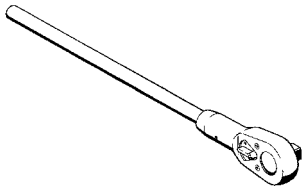
Puller



F6790629a

Part No.:	F6790629
Qty.: Used in:	1 7.6.2 Injector – Removal and installation (→ Page 89)

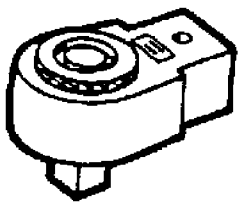
Ratchet



Part No.:	F30006212
Qty.: Used in:	1 7.2.1 Engine – Barring manually (→ Page 75)
Qty.: Used in:	1 7.5.1 Valve clearance – Check and adjustment (→ Page 84)

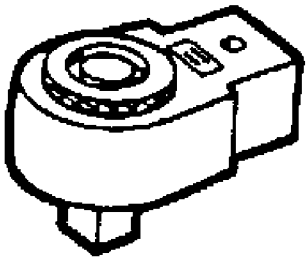
DCL-ID: 000001704 - 004

Ratchet



Part No.:	F30027340
Qty.:	1
Used in:	7.4.2 Crankcase breather – Oil separator element replacement, diaphragm check and replacement (→ Page 82)

Ratchet adapter



Part No.:	F30027339
Qty.:	1
Used in:	7.19.5 Coalescer filter element – Replacement (→ Page 131)

Rigid endoscope

Part No.:	Y20097353
Qty.:	1
Used in:	7.3.1 Cylinder liner – Endoscopic examination (→ Page 77)

Socket wrench

Part No.:	F30030450
Qty.:	1
Used in:	7.5.1 Valve clearance – Check and adjustment (→ Page 84)

DCL-ID: 0000010704 - 004

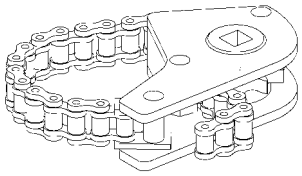
Socket wrench

Part No.:	0005896803/00
Qty.: Used in:	1 7.6.2 Injector – Removal and installation (→ Page 89)

Steam jet cleaner

Part No.:	-
Qty.: Used in:	1 4.13 Plant cleaning (→ Page 62)

Strap wrench

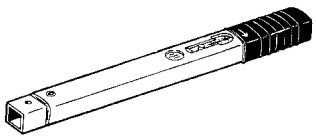


Part No.:	F30379104
Qty.: Used in:	1 7.14.2 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 109)

Torque wrench, 10-60 Nm

Part No.:	F30510423
Qty.: Used in:	1 7.5.1 Valve clearance – Check and adjustment (→ Page 84)

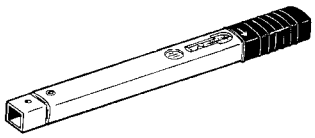
Torque wrench, 6-50 Nm



Part No.:	F30027336
Qty.: Used in:	1 7.19.5 Coalescer filter element – Replacement (→ Page 131)

DCL-ID: 000001070 4 - 004

Torque wrench, 6-50 Nm



Part No.:	F30027336
Qty.:	1
Used in:	7.4.2 Crankcase breather – Oil separator element replacement, diaphragm check and replacement (→ Page 82)

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9.2 Consumables

Cleaner (Hakupur 312)	
Part No.:	30390
Qty.: Used in:	1 4.13 Plant cleaning (→ Page 62)

Cold cleaner (Hakutex 50)	
Part No.:	50622
Qty.: Used in:	1 7.14.2 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 109)

Coolant	
Part No.:	
Qty.: Used in:	 7.15.3 Engine coolant – Change (→ Page 118)

Diesel fuel	
Part No.:	
Qty.: Used in:	 7.8.1 Fuel filter – Replacement (→ Page 92)
Qty.: Used in:	 7.8.3 Fuel prefilter – Draining (→ Page 95)
Qty.: Used in:	 7.8.5 Fuel prefilter – Filter element replacement (→ Page 98)
Qty.: Used in:	 7.19.5 Coalescer filter element – Replacement (→ Page 131)

Engine coolant	
Part No.:	
Qty.: Used in:	 7.15.5 Engine coolant – Filling (→ Page 120)

Engine oil	
Part No.:	
Qty.: Used in:	 7.4.2 Crankcase breather – Oil separator element replacement, diaphragm check and replacement (→ Page 82)
Qty.: Used in:	 7.6.2 Injector – Removal and installation (→ Page 89)
Qty.: Used in:	 7.13.2 Engine oil – Change (→ Page 106)
Qty.: Used in:	 7.14.1 Engine oil filter – Replacement (→ Page 107)
Qty.: Used in:	 7.19.5 Coalescer filter element – Replacement (→ Page 131)

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Fuel	
Part No.:	
Qty.: Used in:	 7.8.4 Fuel prefilter – Flushing (→ Page 96)

Fuel filter shield	
Part No.:	X00009654
Qty.: Used in:	 7.1.2 SOLAS shielding – Installation (→ Page 69)

Grease (Kluthe Hakuform 30-10/Emulgier)	
Part No.:	X00029933
Qty.: Used in:	1 7.6.2 Injector – Removal and installation (→ Page 89)

Isopropyl alcohol	
Part No.:	X00058037
Qty.: Used in:	1 7.20.1 Engine wiring – Check (→ Page 133)
Qty.: Used in:	1 7.21.1 Engine governor and connectors – Cleaning (→ Page 134)

Oil filter shield	
Part No.:	X00009628
Qty.: Used in:	 7.1.2 SOLAS shielding – Installation (→ Page 69)

Shield A4	
Part No.:	735233000100
Qty.: Used in:	10 7.1.1 SOLAS shielding as per MTN 5233 – Installation (→ Page 68)

Shield A5	
Part No.:	735233000101
Qty.: Used in:	14 7.1.1 SOLAS shielding as per MTN 5233 – Installation (→ Page 68)

Shield A7	
Part No.:	735233000103
Qty.: Used in:	6 7.1.1 SOLAS shielding as per MTN 5233 – Installation (→ Page 68)

Shield A8	
Part No.:	735233000104
Qty.: Used in:	2 7.1.1 SOLAS shielding as per MTN 5233 – Installation (→ Page 68)

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9.3 Spare Parts

Air filter	
Part No.:	
Qty.: Used in:	7.10.1 Air filter – Replacement (→ Page 101)

Coalescer filter element	
Part No.:	
Qty.: Used in:	7.19.5 Coalescer filter element – Replacement (→ Page 131)

Coolant filter	
Part No.:	
Qty.: Used in:	7.15.8 Coolant filter – Replacement (→ Page 123)

Diaphragm	
Part No.:	
Qty.: Used in:	7.4.2 Crankcase breather – Oil separator element replacement, diaphragm check and replacement (→ Page 82)

Easy-change filter	
Part No.:	
Qty.: Used in:	7.8.1 Fuel filter – Replacement (→ Page 92)

Filter element	
Part No.:	
Qty.: Used in:	7.4.2 Crankcase breather – Oil separator element replacement, diaphragm check and replacement (→ Page 82)
Qty.: Used in:	7.8.5 Fuel prefilter – Filter element replacement (→ Page 98)

Filter sleeve	
Part No.:	
Qty.: Used in:	7.14.2 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 109)

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Gasket	
Part No.:	
Qty.: Used in:	7.4.2 Crankcase breather – Oil separator element replacement, diaphragm check and replacement (→ Page 82)
Qty.: Used in:	7.5.2 Cylinder-head cover – Removal and installation (→ Page 87)
Qty.: Used in:	7.8.4 Fuel prefilter – Flushing (→ Page 96)
Qty.: Used in:	7.19.5 Coalescer filter element – Replacement (→ Page 131)

Injector	
Part No.:	
Qty.: Used in:	7.6.1 Injector – Replacement (→ Page 88)

O-ring	
Part No.:	
Qty.: Used in:	7.14.2 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 109)
Qty.: Used in:	7.14.2 Centrifugal oil filter – Cleaning and filter-sleeve replacement (→ Page 109)

Oil filter	
Part No.:	
Qty.: Used in:	7.14.1 Engine oil filter – Replacement (→ Page 107)

Plastic ring	
Part No.:	
Qty.: Used in:	7.14.1 Engine oil filter – Replacement (→ Page 107)

Seal	
Part No.:	
Qty.: Used in:	7.8.3 Fuel prefilter – Draining (→ Page 95)
Qty.: Used in:	7.8.5 Fuel prefilter – Filter element replacement (→ Page 98)

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